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Volume 11

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A Result of the 1996 Mueller Commemorative Expedition to Northwestern Australia: *Melaleuca triumphalis* sp. nov. (Myrtaceae)

L.A. Craven

Australian National Herbarium, Centre for Plant Biodiversity Research, CSIRO Plant Industry, GPO Box 1600, Canberra, ACT 2601 Australia

Abstract

The new species, *Melaleuca triumphalis* Craven, is described and illustrated and its distribution is mapped. A key to distinguish it from its closest congeners (*M. nervosa and M. fluviatilis*) is provided.

Introduction

An expedition to the Victoria River region in northwestern Australia was undertaken in 1996, in part to commemorate the achievements of Ferdinand Mueller when he participated as botanist on Augustus Gregory's North Australian Expedition of 1855–56 (Walsh 1996). Among the interesting species that were collected during the recent expedition was a new species of *Melaleuca*, the subject of the present paper.

Melaleuca triumphalis Craven, *sp.nov.*

Affinis *M. nervosae* (Lindl.) Cheel a qua frutice usque 2.5 m alto, cortice caulium subpapyraceo (arcto fissuratoque), indumento ramulorum hirto (trichomatibus pubescentibus perlongis), foliis apice acutis usque anguste acutis, lobis calycis 1.9–2.5 mm longis, petalis 5.1–7 mm longis, staminibus 7–12 in quoque fasce, ovulis c. 120–160 in quoque loculo, infructescentiis 15–17 mm latis, et fructibus minimum annis aliquot persistentibus differt.

Type: Northern Territory: Gregory National Park, Victoria River Gorge, c. 6 km SW of the Victoria River roadhouse, 17 Sep 1996, *Cowie and Mangion* 7327 (holotype CANB; isotypes DNA *n.v.*, MEL, NSW).

Shrub to 2.5 m tall; bark grey, tight, fissured, subpapery. *Indumentum* of branchlets and leaf blades shaggy, with very long, straight, spreading-ascending to spreading hairs overtopping a dense layer of very short pubescent to lanuginulose hairs. *Leaves* spiral, ascending to spreading, the petiole 5–15 mm long, the blade isobilateral, narrowly elliptic, 60–140 mm long, 15–25 mm wide, 4–6 times as long as wide, the base narrowly cuneate or attenuate, the apex acute or narrowly acute, veins 3–5, silvery at first due to the dense hair covering but becoming glabrate and greenish with age, the oil glands scattered. *Inflorescence* a head or short spike of triads (although spicate in bud, at anthesis the inflorescence is shorter than wide), up to 65 mm wide; with 10–20 triads per inflorescence. *Hypanthium* with puberulous and lanuginulose hairs (extremely dense puberulous hairs grade through to sparser lanuginulose hairs), cup-shaped (sometimes approaching cylindrical), 2.8–4.6 mm long, 3–3.9 mm wide. *Calyx lobes* 5(–7) (some flowers have 1 or 2 additional sepals outside the usual 5), herbaceous to or almost to the margin, 1.9–2.5 mm long, with

puberulous, lanuginulose, and sericeous-pubescent hairs (the indumentum is much like that of the hypanthium but has an overstorey of much longer sericeous-pubescent hairs; *Petals* hairy, distinctly clawed, ovate or elliptic, 5.1–7 mm long. *Stamens* 7–12 per bundle; the filaments glabrous, green (described as turning yellow with age), 19.5–24.3 mm long, the bundle claw 2–16.5 mm long (very long claws occur when two or more of the filaments are fused for a large proportion of their length, it may not be all of the filaments that diverge at this length). *Style* 27.5–35.3 mm long. *Ovules* c. 120–160 per locule. *Infructescence* 15–17 mm wide; fruit not early dehiscent and apparently persisting for several years, the fruiting hypanthium 3.7–5.6 mm long, 4.1–6.7 mm wide, 1.8–3.6 mm wide at the orifice. *Seed* with the cotyledons obvolute. (Fig. 1)

Other Specimens Examined

Northern Territory: Gregory National Park, Victoria River Gorge, c. 7.3 km SSW of the Victoria River roadhouse, 17 Sep 1996, *Cowie and Mangion 7325* (BRI, CANB, DNA *n.v.*, PERTH, QRS); *ditto*, c. 8 km SSW of the Victoria River roadhouse, 17 Sep 1996, *Cowie and Mangion 7321* (CANB, DNA *n.v.*); *ditto*, c. 6 km SSW of the Victoria River bridge, 17 Apr 1996, *Albrecht and Latz 7426* (CANB, DNA *n.v.*, MEL *n.v.*). The Albrecht and Latz collection probably is from the same location as *Cowie and Mangion 7325* (Cowie, personal communication).

Distribution and Ecology

Known only from the Victoria River Gorge and associated gorges in the Northern Territory (Fig. 2). Recorded on herbarium labels as occurring in crevices on a south facing sandstone cliff; below cliffs at the base and to the side of a seepage area at the head of a small valley; at the top of a scree slope near the base of an ephemeral waterfall in an area with perennial seepage; in crevices in a gorge cliff face with the area a waterfall in the wet season. Associated plants include *Baeckea, Livistona, Ficus, Eucalyptus* and ferns. In sumary, *M. triumphalis* grows in sites with perennial seepage near the base of ephemeral waterfalls, either at the top of scree slopes or in crevices near the base of the cliff (Cowie, personal communication).

Notes

In the possession of lanuginulose hairs and longish, greenish stamens, *M. triumphalis* is very similar to *M. nervosa* (Lindl.) Cheel and *M. fluviatilis* Barlow. Inter alia, it differs from these two species in bark and indumentum features as given below. The flowers consistently are closely clustered whereas in *M. nervosa* and *M. fluviatilis* they usually are dispersed on the inflorescence axis. Additionally the new species has a very different ecology; *M. nervosa* and *M. fluviatilis* occur in woodlands and riverine situations, respectively.

Melaleuca triumphalis can be distinguished from *M. nervosa* and *M. fluviatilis* by the following key:

1. Trunk bark subpapery (tight, fissured); branchlet indumentum shaggy (the pubescent hairs very long); petals 5.1–7 mm long, hairy with the hairs distributed moderately densely and evenly all over or along the central region ....*M. triumphalis*
1. Trunk bark papery; branchlet indumentum never shaggy (pubescent hairs, if present, very short); petals 1.5–3.5 mm long, usually glabrous or sometimes with hairs abaxially along the central region................*M. nervosa, M. fluviatilis*

This species is remarkable for its shaggy indumentum; this is especially obvious on the branchlets. The shrubby habit, together with the silvery leaves and greenish flowers, renders the plant a very suitable subject for trial as an ornamental shrub or

small tree in northern Australia and seed has been collected with this view in mind (Cowie, personal communication).

The specific epithet is derived from the Latin *triumphalis* (pertaining to a triumph, triumphal) and reflects both the results achieved by Mueller while a member of the Gregory expedition and the collection of this previously unknown species on the recent expedition commemorating Mueller's work.

Acknowledgments

David Albrecht and Clyde Dunlop are thanked for bringing the Albrecht and Latz collection, made during the 1996 Mueller Commemorative Expedition, to my notice and Ian Cowie is thanked for making further collections of the species on my behalf and for providing further information on the species. Julie Matarczyk assisted with data collection. The plate was prepared by Catherine Wardrop. Preparation of this paper in part was supported by the Australian Biological Resources Study.

Reference

Walsh, N. (1996). Gregory National Park: the 1996 Mueller Commemorative Expedition. Australian Systematic Botany Society Newsletter **89**, 40–41.

Fig. 1. *Melaleuca triumphalis.* **a** habit; **b** flower with one petal removed; **c** detail of leaf indumentum; **d** fruit (a,c from *Cowie and Mangion 7327*; b from *Cowie and Mangion 7325*; d from *Albrecht and Latz 7426*). Scale bars represent 1 cm.

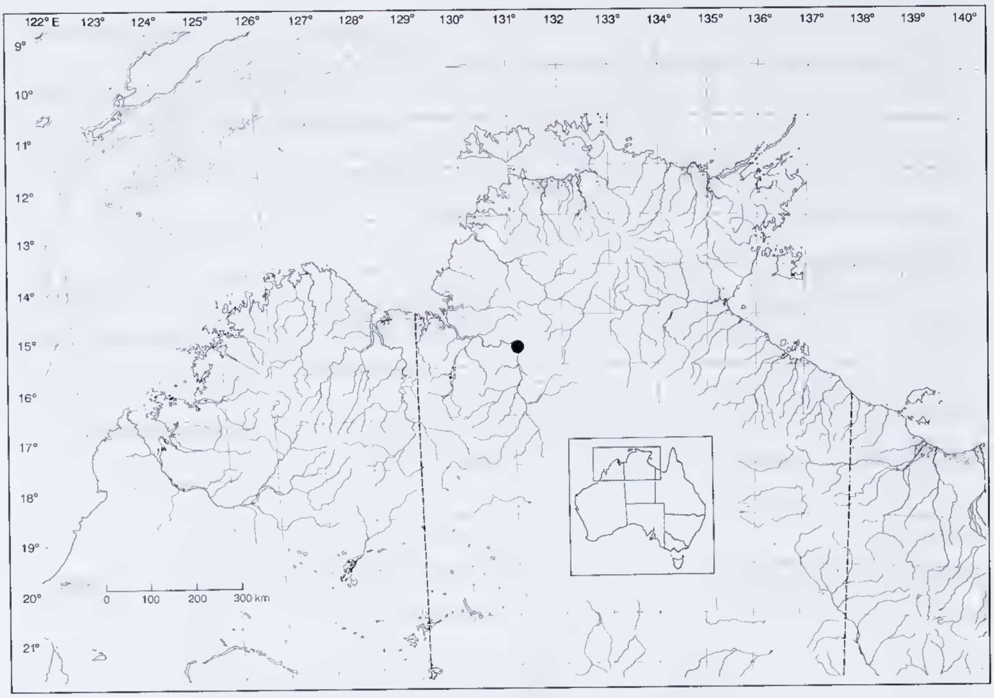

Fig 2. Distribution of *Melaleuca triumphalis*.

Muelleria 11: 5–11 (1998)

Notes On Western Australian Bossiaea Species (Fabaceae): 3

J. H. Ross

National Herbarium of Victoria, Royal Botanic Gardens, Birdwood Avenue, South Yarra, 3141, Australia.

Abstract

Two leafless Western Australian Bossiaea species, *B. halophila and B. cucullata*, are described as new. Descriptions, illustrations and distributions are provided. Both species are associated with salt lake systems. The likely pollination syndrome for each species is discussed briefly.

Introduction

The only comprehensive account of the Western Australian *Bossiaea* species was provided by Bentham (1864) in his treatment of the entire genus. This paper is the third in a series dealing with the Western Australian species (Ross, 1994a, 1994b). Recent studies have disclosed the existence of two undescribed species that are associated with salt lake systems in south-western Western Australia. Names for these two species are made available now rather than waiting until a full revision is completed.

Bossiaea halophila J.H. Ross, sp. nov.

Bossiaea leptacanthae E. Pritz. affinis, a qua habitu largiore multo, bracteolis caducis cito, floribus grandioribus, petalis carinae apicibus et sinubus pubescentibus, ovariis sutura supra pilis vestitis, differt.

Type: Western Australia, W shore of Lake King near start of causeway, 1 Nov. 1996, *M.G. Corrick* 11479 (holotypus MEL; isotypi CANB, K, NSW, NY, PERTH)

Shrub, rigid, erect, much-branched, to 1.4 m high and 2 m wide, almost completely glabrous except for hairs in the axils of the scale leaves and scattered hairs on young growth; branches ascending, flattened or elliptic, ultimate branches of cladodes 0.75–2.2 mm wide, scarcely or narrowly winged, notched at the nodes, sometimes ending in an acute point but scarcely pungent-pointed, longitudinally striate, growth of current season green or greenish-blue but older growth usually with a thin greyish-white waxy surface that exfoliates when the branches dry. *Leaves* reduced to ovate brown scales up to 1.8 mm long, alternate. *Flowers* solitary at the nodes, pedicellate, the pedicels 6–8 mm long, glabrous throughout or with scattered appressed hairs. *Bracts* several, soon deciduous, brown, ovate, increasing in size towards the apex of the pedicel, the uppermost up to 0.7 mm long, with conspicuous marginal cilia; bracteoles usually inserted above the middle of the pedicel, overlapping the base of the calyx in bud but rapidly deciduous, narrow-elliptic, up to 1.7 mm long, scarious, longitudinally striate, with marginal cilia, the cilia prominent apically. *Calyx* green but the upper lobes suffused with pink or red, the median line darker, usually glabrous throughout externally apart from cilia on the margins of the lobes but occasionally with a few scattered appressed hairs towards the apices of the lobes or sometimes throughout: 2 upper

lobes 4.7–6.5 mm long including the tube 3.3–4 mm long, 3 lower lobes 1.1–2 mm long. *Standard* about as long as or slightly longer than the keel petals, 10–13.5 mm long including a claw 2–5.5 mm long, 8.8–9.5 mm wide, yellow internally with a reddish-brown throat from which numerous red-brown longitudinal striations radiate into the lamina, yellow externally apart from the red-brown base from which red-

Fig. 1. *Bossiaea halophila.* **a** flowering twig, x 0.8; **b** calyx opened out, upper lobes on right, x 2.4; **c** standard, x 2.4; **d** wing petal, x 2.4; **e** keel petal, x 2.4; **f** fruiting twig, x 1 (*Corrick 11479*); **g** seed, hilar view, x 8; **h** seed, side view, x 8 (*Ross 3866*).

brown longitudinal striations radiate into the lamina; wings about as long as the keel petals, 9–10.5 mm long including a claw 2.5–3.8 mm long, 1.9–2.8 mm wide, yellow throughout or with a longitudinal red-brown striation towards the lower margin; keel petals 9.5–10.6 mm long including a claw 3–4 mm long, 3.5–4.2 mm wide, pale greenish-yellow throughout or sometimes with a red-brown longitudinal striation towards the lower margin, with woolly hairs apically and in the sinus. *Stamen-filaments* 7.2–10.8 mm long. *Ovary* 5–7 mm long, on a stipe 1.2–3.2 mm long, glabrous apart from hairs on the upper suture, 6–10-ovulate; style 2.4–4 mm long. *Pods* oblong, 1.3–3 cm long, 0.4–0.6 cm wide, stipe about as long as the calyx-tube, valves with appressed hairs on the margins when young but glabrescent, transverse venation not conspicuous, pale chestnut- or pinkish-brown. *Seeds* elliptic-oblong, 2.6–3.4 mm long, 1.6–2.3 mm wide, a uniform pale fawn, the small hilum covered by a hooded cap-like aril. (Fig. 1)

Representative specimens (13 examined):

Western Australia: Pingrup, x.1933, *W.E. Blackall 3097* (PERTH); 10km W of Pingaring, 12.x.1977, *G.J. Keighery 1104* (PERTH). 10.6 km SE of Hyden on Hyden-Varley Rd., 27.xi.1996, *J.H. Ross 3862* (MEL, PERTH). W shore of Lake King, 12 km W of Lake King general store on Lake King-Newdegate Rd., 27.xi.1996, *J H Ross 3866* (CANB, MEL, PERTH); W shore of Lake Grace, 8.6 km W of Lake Grace Post Office on Lake Grace-Kukerin Rd, 28.xi.1996, *J.H. Ross 3873* (MEL, PERTH).

Distribution and Conservation Status

Occurs in the Roe Botanical District of the Southwestern Botanical Province as defined by Beard (1980) where it is recorded from the vicinity of Pingaring to SE of Hyden in the north, southwards to the vicinity of Pingrup in the west with an outlying population at Lake King. *Bossiaea halophila* is not considered rare or threatened at present. (Fig.2)

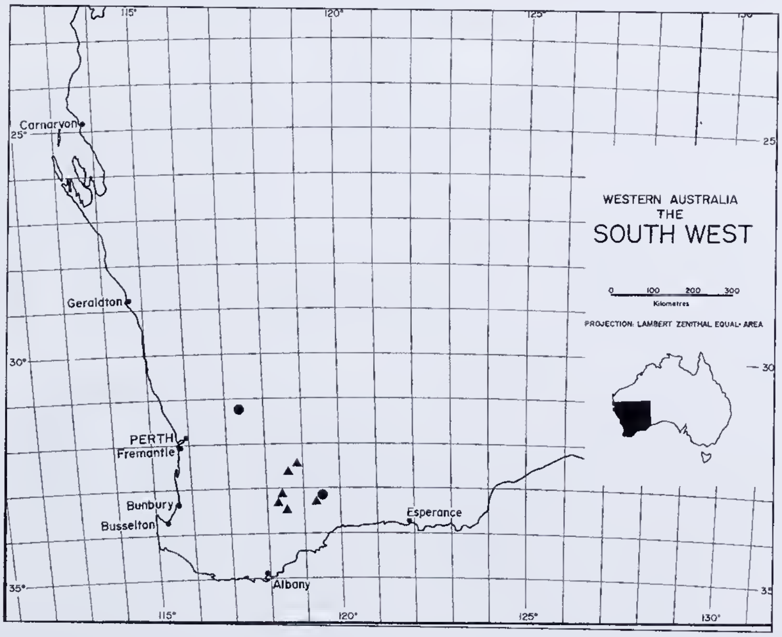

Fig 2. Distribution of *Bossiaea halophila* (▲) and *Bossiaea cucullata* (●) in Western Australia

Habitat

Favours well-drained deep sand around salt lake systems. Often in association with mallee eucalypts, *Melaleuca* spp., and Chenopodiaceae, sometimes also with *Santalum acuminatum* and *Scaevola spinescens*. On the western shore of Lake King *B. halophila* grows in association with *B. cucullata*.

Phenology

Recorded flowering in May, September to early November. Fruits: November and December.

Notes

Bossiaea halophila differs from *B. leptacantha* in being a much larger erect shrub with ascending branches (*B. leptacantha* grows as a low spreading shrub which branches at ground level and usually lacks a single well-defined erect aerial stem), in having the ultimate cladodes more distinctly flattened, the older stems with a thin waxy layer that exfoliates tardily (this layer is much thinner and less conspicuous than in *B. leptacantha*), the bracteoles on the pedicels rapidly deciduous, larger flowers, the keel petals clothed with scattered woolly hairs apically and in the sinus, and the ovaries with scattered hairs on the upper suture. Flower colour also differs. The flowers in *B. leptacantha* are usually uniformly yellow although on occasional plants the standard has a basal red flare internally from which red striations radiate into the lamina; in *B. halophila* the standard is yellow internally with a reddish-brown throat from which reddish-brown striations radiate into the lamina.

The ecological preferences of the two species differ; *B. leptacantha* favouring sandy soil, clay or clay-loam, often over limestone, and frequently away from salt lake systems whereas *B. halophila* favours deep sand near salt lake systems. The distribution of the two species does not overlap, *B. leptacantha* occurring much further east than *B. halophila* from the vicinity of Peak Charles in the west to Madura in the east.

The predominantly yellow flowers with reddish-brown longitudinal striations suggest that *B. halophila* is pollinated by insects.

Etymology

From Greek and meaning 'salt-loving', in allusion to the preferred habitat of the species on the margins of salt lake systems.

Bossiaea cucullata J.H. Ross, sp nov.

B. walkerae F. Muell. affinis, a qua floribus coloratis aliter, bracteis et bracteolis ad 1 mm longas, bracteolis persistentibus, pedicellis infra bracteolas pubescentibus, leguminibus brevioribus et angustioribus plerumque, differt.

Type: Western Australia, western shore of Lake King, 14.x.1997, *B.Archer* 840 (holotypus MEL; isotypi K, PERTH)

Shrub, rigid, erect, dense, multi-stemmed, intricately branched, to 2 m high and 3 m wide, almost completely glabrous; branches terete to oval or slightly flattened, ultimate branches of cladodes 2–5 mm wide, narrowly winged, notched at the nodes, sometimes terminating in a pungent point, usually with a white waxy surface that exfoliates when the branches dry, sparingly to densely clothed with appressed hairs when young. *Leaves* reduced to scales c. 2 mm long, alternate. *Flowers* solitary at the nodes or rarely paired, pendulous, pedicellate, the pedicels up to 5mm long, usually glabrous above the bracteoles and sparingly clothed with appressed hairs below. *Bracts* several, distichous, brown, broad-ovate, increasing in size towards the apex of the pedicel, the uppermost up to 1 mm long, with conspicuous marginal cilia and densely clothed externally with appressed hairs;

bracteoles inserted towards the middle of the pedicel, broad-ovate, up to 1mm long, brown, with marginal cilia and scattered appressed hairs externally especially towards the apex, persisting until the pods mature. *Calyx* green suffused with purplish-brown on the adaxial surface, glabrous externally apart from the ciliate margins of the lobes, pubescent internally, persisting until fruits mature: 2 upper

Fig. 3. *Bossiaea cucullata.* **a** flowering twig, x 0.8; **b** calyx opened out, upper lobes on right, x 2.4; **c** standard, x 2.4; **d** wing petal, x 2.4; **e** keel petal, x 2.4 (*Corrick 11227*); **f** fruiting twig, x 0.8; **g** seed, hilar view, x 8; **h** seed, side view, x 8 (*Ross 3865*).

lobes much larger than the lower three, 10.5–14.4 mm long including the tube 3–3.5 mm long, 3 lower lobes 1.5–2.4 mm long, somewhat recurved apically. *Standard* much shorter than the keel petals, 12.5–14.4 mm long including a claw 4.5–5 mm long, 14–15.5 mm wide, deep yellow or orange-yellow externally and sometimes suffused with dark red or purple apically; wings about the same length as the standard and much shorter than the keel petals, 13.2–15 mm long including a claw 3.5–4 mm long, 3.7–4 mm wide, same colour as standard; keel petals 22.8–26 mm long including a claw 2.6–4 mm long, 6–8 mm wide, deep red. *Stamen-filaments* 16.5–29 mm long. *Ovary* 5–15 mm long, on a stipe up to 5 mm long, glabrous, 10–18-ovulate; style 8.5–10.2 mm long. *Pods* oblong, 2.5–4.8 cm long, 0.5–0.7 cm wide, stipe about as long as the calyx-tube but much shorter than the upper lobes, valves glabrous, not conspicuously transversely venose, pale brown or greenish-brown and often suffused with pink. *Seeds* elliptic-oblong, 2.6–4.1 mm long, 1.9–2.6 mm wide, with black mottles on a yellow or olive background, seldom uniformly yellow or olive. (Fig. 3)

Representative specimens (12 specimens examined):

Western Australia: Lake Derdibin, 16 km S of Wyalkatchem, 21.ii.1992, *B.H. Smith 1641* (MEL, PERTH); 13.x.1993, *B.H. Smith 1703* (MEL, PERTH); 25.x.1994, *B.H. Smith 1743* (MEL); western edge of Lake King, 7.ix.1986, *P.S. Short 2747* (CANB, MEL, PERTH); 24.ix.1996, *M.G. Corrick 11227* (MEL); 27.xi.1996, *J.H. Ross 3865* (CANB, MEL, PERTH).

Distribution and Conservation Status

Known only from Lake Derdibin and Lake King in the Avon and Roe Botanical Districts respectively of the Southwestern Botanical Province as defined by Beard (1980). These two populations are separated by a distance of over 200 kilometres. The Lake Derdibin population consists of about forty individuals and the Lake King population of over one hundred. As *B. cucullata* is known currently from only two populations, it is considered rare. The Western Australian Conservation Code of Priority 4 is considered appropriate for this species. (Fig. 2)

Habitat

Favours deep gypsum sand near salt lakes. The northern population occurs about 50 metres from the southern shore of Lake Derdibin in association with *Melaleuca thyoides* and several Chenopodiaceae. It is a harsh site where the plants grow as dense impenetrable shrubs. The older branches are covered with a white 'bloom' which imparts a greyish-white hue to the plants. The southern population grows near the western shore of Lake King but the site appears slightly less inhospitable and the plants tend to be smaller and more open.

Phenology

Flowers September and October. Fruits: November and December.

Notes

Superficially similar to *B. walkeri* with which *B. cucullata* was initially confused. However, *B. cucullata* differs from *B. walkeri* in having differently coloured flowers; in *B. walkeri* the standard is usually uniformly red or salmon pink (rarely pale yellow) or occasionally suffused with orange or sometimes burgundy basally, whereas in *B. cucullata* the standard is predominantly deep yellow or orange-yellow externally throughout or suffused with dark red or purple apically. The yellow standard in *B. cucullata* contrasts strongly with the deep red or burgundy keel petals, the lower three calyx lobes are smaller in relation to the size of the upper lobes than is the case in *B.*

walkeri, the bracteoles persist on the pedicel until the pods mature, the bracts and bracteoles are smaller (to 1mm long), the pedicels are pubescent below the point of attachment of the bracteoles, and the pods are usually shorter and narrower.

In contrast to *B. walkeri* which has a widespread distribution in southern mainland Australia and grows in a variety of habitats, *B. cucullata* is known from only two disjunct localities in Western Australia and is confined to deep sand near salt lakes. A close inspection of the numerous salt lakes that occur in the area between the two populations may reveal additional populations. *Bossiaea cucullata* grows in closer proximity to salt lakes than *B. walkeri* and presumably is more tolerant of salt than the latter species. The distribution of the two species does not appear to overlap.

The pendulous tendency of the flowers, the reduced size of the standard and wing petals, and the large elongated red keel petals suggest that *B. cucullata* is pollinated by birds (probably honeyeaters). As far as is known, there are no direct observations of birds visiting flowers of *B. cucullata* but a visit to the Lake King population in spring would surely remedy this deficiency. The flowers of *B. walkeri* are also thought to be pollinated by birds. Bird-pollination is relatively common among genera of the tribe Mirbelieae (Crisp 1996).

There is a suggestion that flower colour in the two populations may differ slightly but, apart from this and the differences in growth form, no significant differences have been noted between the plants in the two populations.

The species is depicted as *Bossiaea* sp. in Corrick and Fuhrer 56, pl.129 (1996).

Etymology

From the Latin *'cucullus'*, a hood, in allusion to the two enlarged upper calyx lobes that tend to form a hood over the pendulous flower.

Acknowledgements

I am most grateful to Basil and Mary Smith for their hospitality and for responding to requests for additional material of *B. cucullata* over the years. I am especially grateful to Basil for venturing out one incredibly hot summer day to take me to visit the population of *B. cucullata* at Lake Derdibin. I am grateful to the Director of the Western Australian Herbarium for access to collections and for the loan of material, to my colleagues Neville Walsh for checking the Latin diagnoses and Mali Moir for executing the illustrations that accompany this paper; to Margaret Corrick for collecting excellent material of both species in response to requests, and to Barbara Archer for providing excellent collections, photographs, and specific information about *B. leptacantha*.

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The Vegetation of the Chatham-Islands by Ferdinand Mueller (1864): An Appreciation

H.E. Connor

Department of Geography, University of Canterbury, Christchurch, New Zealand.

Abstract

Mueller's *Vegetation of the Chatham-Islands* is reviewed in late 20th Century terms for its contribution to taxonomic botany in New Zealand and, despite some criticism at the turn of this century, is not found deficient in its treatment. It was unlike Hooker's contemporary flora and difficult in its diction, and apart from essential taxonomic and nomenclatural uses, has not earned any significant reputation for its intrinsic merits.

Introduction

In 1864 Ferdinand Mueller F.R.S. published his sole essay into the Flora of New Zealand in *The Vegetation of the Chatham-Islands*; John Ferres, Government Printer, Melbourne, was as usual his printer. Mueller, on the title page, appropriately used the expression "sketched by" for he had not visited the Chatham Islands (44°S, 176°W), but wrote from collections made in 1863 by H.H. Travers, who at his father's (W.T.L. Travers) instruction and personal expense spent six months on the Islands to examine their botany, ornithology, and anthropology (Travers, H.H. 1869; Travers, W.T.L. 1872). Although some earlier collections by Dr E. Dieffenbach and Captain Anderson were available, the specimens of H.H. Travers at Mueller's disposal, numbering perhaps one hundred ferns and higher plants (N.G. Walsh *in litt.*), were his chief source of information of a flora largely unknown at the time.

There was no discussion or criticism of Mueller's *Vegetation* until the early 20th century although there was dissatisfaction over his failure to add to it the results of a second collecting expedition in 1871. If J.D. Hooker was incommoded by its contemporaneous publication with his *Handbook of the New Zealand Flora* (1864), there is no evidence for it.

In this paper the mid-19th century contribution by Mueller to the taxonomy of the New Zealand flora is assessed through a comparison of his treatment of Chatham Islands plants with that of the late 20th century. My conclusion is that *Vegetation* is a competent work from which only those essential elements of nomenclature have been drawn.

Travers, The Chatham Islands flora, and Mueller

Mr W.T.L. Travers (1819–1903), a former soldier who became a leading figure in science, law, and Government, sent many specimens to the Hookers at Kew from about 1854 onwards, evidenced from the many citations in Hooker's *Handbook of the New Zealand Flora* (1864, 1867); his only son, H.H. Travers, also collected specimens in mountainous areas (Buchanan 1872).

W.T.L. Travers resided in Christchurch from 1860 to 1869 during the local scientific ascendancy of German-born Julius Haast (1822–1887). Haast and Travers

were in close contact; Haast and Mueller had been in direct contact since 1859 (von Haast 1948). Haast promoted the idea of a Chatham Islands exploration and W.T.L. Travers financed it. H.H. Travers made the journey and collected the plants which W.T.L. Travers presented to the Phytological Museum of Melbourne.

Mueller already had an interest in the flora of the Chatham Islands because in 1858 he received as the result of "... temporary direct trade between Melbourne and the Chatham-Islands ..." plants from Anderson, and others through the offices of Dr I.E. Featherstone, Superintendent, Province of Wellington. As a direct result Mueller developed an interest in the Islands. On the receipt from A.J. Ralston, Melbourne, of some flowering and fruiting plants of the Chatham Islands endemic *Myosotidium hortensia*, an essay on "... that singular plant described as Cynoglossum Chathamicum was read before the Philosophical Institute of Victoria ..." (Mueller 1864, p. 2) but was never published because "... the venerable Sir Will. Hooker had given an account of the same plant". J.D. Hooker (1858) named it *Cynoglossum nobile*.

The scientific background against which H.H. Travers' Chatham Island specimens were sent to Mueller from the 1863 visit is easily described. At the time of Travers' visit William Colenso was the most reknowned resident collector and describer of indigenous plants; much he sent to Kew. W.T.L. Travers arrived in New Zealand in 1849, and from about 1854 became another among those botanists who sent specimens to the Herbarium at the Royal Botanic Gardens, Kew. When H.H. Travers went to the Chathams, scientific institutes did not exist in New Zealand. The Colonial Museum was founded in 1865, and J. Buchanan transferred from Dunedin to Wellington to join it. The Canterbury Museum, under J. Haast, was founded in 1865 at the same time as the Otago Museum. T.F. Cheeseman was appointed Secretary of the Auckland Institute and Curator of the Auckland Museum in 1874 following T. Kirk who held the position from 1868. None of these institutes was available to Travers until the time of his second trip of 1871.

The traditional home for the Travers' specimens would have been the Herbarium at Kew to which a set of specimens was sent as a donation to Sir William Hooker, and was used by J.D. Hooker for his *Handbook* (Nelson 1989). W.T.L. Travers presented the Chatham Island specimens to MEL (Mueller 1864, p. 3) but Nelson (1989) reported that H.H. Travers was the donor. The collection arrived at MEL around June 1864 for Mueller's attention (S. Maroske *in litt.*).

This interest in the plants of the Chatham Islands was expressed by Mueller in his letter of self-introduction to Haast (23 November 1859); he noted that the islands were botanically unexplored and wondered if someone could go there to study their natural history. By early 1862 (letter of 3 March to Haast) Mueller's ambitions were clear: (i) he wanted to prepare a sketch of the vegetation of the Chathams; (ii) he wanted to send a collector to the islands; (iii) he wanted exclusive use of any specimens ("Für die Arbeit möche ich gern die Materialien Monopol besitzen"); (iv) he wanted to read a paper to the Philosophical Society for which the vegetation of the islands would provide a splendid theme.

On Haast's intimation to J.D. Hooker that Mueller was going to prepare an account of the Chatham Islands plants Hooker expressed the fervent hope that Mueller would not do so for reasons outlined below (J.D. Hooker *in* H.F. von Haast 1948). In the event, the *Vegetation* was published in 1864.

William Thomas Locke Travers and Henry Hammersley Travers

There should be no room for confusion over the two Travers, father and son, and the Chatham Island collections. Yet there is. It is clear from Mueller (1864, p. 3) that

H.H. Travers went to the Chathams in 1863. Confirmation is in H.H. Travers (1869) where his departure is "... 12th of October last", on the schooner "Cecilia".

Nevertheless it is twice asserted that W.T.L. Travers visited the Islands (Given and Williams 1985; Given 1996), and to add to the confusion Hooker in his *Handbook of the New Zealand Flora, Part II* (1867, p. 722) cites". Mr W. Travers' collections" as the basis for Mueller's *Vegetation.* Further, or perhaps worse, throughout pp. 722–750 of the *Handbook*, "Chatham Island, *W. Travers*" occurs about 80 times. Buchanan (1875) unhelpfully gives the date of H.H. Travers' first trip as 1866, and W.T.L. Travers (in Travers, H.H. and Travers, W.L.T. 1873) as 1867.

That W.T.L. Travers accepted Haast's concept of a Chatham Islands exploration was consistent with his broad intellectual ambitions for New Zealand science. Today the Travers Chatham Island specimens are in MEL and K. They are also in WELT, and H.F. von Haast (1948) in an entry in the index to his father's biography, but unlocatable in the text of his book, indicated that the 1863 Chatham Island specimens were presented by W.T.L. Travers, Christchurch, to the recently founded Colonial Museum in Wellington.

Date of publication of The Vegetation

Mueller's preface is dated 15 September 1864 and the volume was published before 10 October of that year (N.G. Walsh *in litt*); the edition comprised 522 copies (S. Maroske *in litt.*). The publisher is given as Government Printer, Melbourne, but von Haast (1948, p. 250) leaves the impression that W.T.L. Travers paid for the publication as well as for the expedition. Hooker's *Handbook of the New Zealand Flora Part I* was published September to October 1864, and thus its contents were unavailable to Mueller. The effect is minimal: see *Cyathodes robusta, Tetragonia trigyna* for names given priority over trinomials in Mueller.

The title of Mueller's book is interesting; it does not describe the vegetation of the Chatham Islands in the way Cockayne (1902) did forty years later. It is a "Flora of the Chatham Islands". Mueller, reporting as he does those plants typical of the sand dunes, the volcanic cones, the coastal and lowland forests, the limestone habitats, and the peat, accounts in a non-ecological way for the vegetation of the Chatham Islands as revealed to him by H.H. Travers' collections, notes, and diary - the diary since destroyed.

The "Enumeration"

Mueller in flora style listed the Chatham Island plants by family, genus, and species under the major subtitle "The Enumeration of the Plants of the Chatham-Islands". He listed 87 species in 67 genera, by his own reckoning, in what he later referred to as my "Sketch" (Mueller 1873). These taxa can be examined in several ways but I choose to examine them as listed by Mueller, give their current status, and draw conclusions from the comparison of 1864 and 1997 interpretations. Authorities for binomials are in Tables 1 and 2 unless essential to the discussion. Nomenclature for New Zealand taxa follows Allan (1961), Moore and Edgar (1970), and Connor and Edgar (1987) unless otherwise stated. There are five groups.

(i) Taxa described as new by Mueller

Mueller described eight species of flowering plants as new to botany, and five new varieties of established species; six pteridophytes were given status in new combinations. These and their current taxonomic status are in Table 1.

Almost all are endemic taxa currently (a) accepted unchanged e.g. *Leptinella featherstonii* and *Myrsine chathamica*; (b) transferred to different genera e.g. *Eurybia traversii* in *Olearia*, and *Senecio huntii* in *Brachyglottis*; (c) accepted at different taxonomic levels e.g. *Hymenanthera latifolia* var. *chathamica* as *Melicytus chathamicus*; (d) or instantly transferred by Hooker (1867), as in *Gingidium traversii* to *Aciphylla*. None of the pteridophytes is endemic.

Hooker's simultaneous publication in the *Handbook* (1864) of a name unknown to Mueller resulted in *Tetragonia trigyna* predating *T. implexicoma* var. *chathamica* and the loss of status as an endemic taxon.

Mueller was expansive on *Leptinellae* (*Veg. Chatham-Is.* pp. 27–30) associating *L. potentillina* with 10 other species whose characteristics are set out simply. Though displaying hesitation over the remarkable habit of *L. featherstonii* which, had it not been clearly a species of *Leptinella*, he was prepared to have awarded generic recognition as *Traversia* with a clearly implied commemoration for H.H. Travers. Had that transpired an immediate conflict would have arisen with Hooker's *Traversia* of 1864 which commemorated W.T.L. Travers. Any doubt as to which Travers was being commemorated in *Eurybia traversii* was removed by Mueller's economic commemoration of both W.T.L. and H.H. Travers in the one taxon.

In general Mueller's taxonomic perceptions were accurate, and not unexpectedly the generic disposition of some taxa differs from current practice.

(ii) Currently accepted names from Mueller's synonymy

As has been remarked upon by all commentators, Mueller included many binomials in synonymy — 15 species of *Epilobium* in *E. tetragonum*; nine species in *Gentiana saxosa* with the observation that "It is evident that the number of described Gentianae must be largely reduced" (p. 41). Seventeen names have been reinstated in the Chatham's flora; these are listed in Table 1 as "in synonomy of ..." together with the name used by Mueller. *Epilobium* is a simple case; six taxa, all with Travers' specimens at MEL, were recognized by Raven and Raven (1976) to replace the single entry "*E. tetragonum*". For the rest, apart from nomenclatural synonymy (*Sophora-Edwardsia, Deschampsia-Aira, Paesia-Pteris*), most changes are simple ones, e.g., *Calystegia soldanella* for *C. sepium*.

From the *Veronica* mélange of 22 names submerged under the invalid binomial *V. forsteri*, the endemic *Hebe dieffenbachii* has been restored; other species of *Hebe* now recognized were described later, of which two are endemic: *H. barkeri* and *H. chathamica* (Table 2).

The endemic *Olearia semidentata* was restored from Mueller's transfer to *Eurybia*.

(iii) Taxa listed by Mueller under names not currently accepted

Another suite of names for native plants has replaced those used by Mueller in 1864. Eleven of them are pteridophytes; Brownsey *et al.* (1985) are clear on the current names for ferns and lycopods to replace those in Mueller by citing his *Vegetation* in 12 separate entries. Such assurance does not extend to all groups.

All names are listed in Table 1 together with the dates for the new or corrected post-*Vegetation* names. Some entries are simple ones — *Coriaria arborea* as the name of an indigenous species to replace *C. ruscifolia*;

Urtica australis for *U. incisa*. Five grasses received full notes, and under *Festuca littoralis* (*Veg. Chatham-Is.* 59) Mueller treated *Festuca* as he saw it, distributed across generous areas of Australia, and in which he included species of *Triodia*.

Entries in this class are distinguished in Table 1 as e.g. '*Libertia peregrinans* Cockayne and Allan 1926; as *L. ixioides* Sprengel (*Veg. Chatham-Is.* 53).'

It is possible to associate current names with all taxa listed in Mueller except for *Avicennia officinalis* collected by E. Dieffenbach (*Veg. Chatham-Is.* 75); Mueller's final note "Eurybia [*Olearia*] traversii in a flowerless state bears considerable resemblance to Avicennia officinalis" may be significant. No one has commented since, and *A. resinifera* is unknown there.

(iv) Taxa listed by Mueller under names currently accepted

Nineteen names still in current use were correctly used by Mueller for native plants. These in Table 1 are simple and direct entries e.g. *Calystegia sepium* R.Br. (*Veg. Chatham-Is.* 38); *Lobelia anceps* Thunb. (*Veg. Chatham-Is.* 31); *Solanum aviculare* G. Forst. (*Veg. Chatham-Is.* 31); two are naturalized species. None of them is significant except perhaps *Euphorbia glauca* which is based on a specimen lost by H.H. Travers. Five are pteridophytes, four monocotyledons, four are trees or shrubs. On the whole it is an undistinguished list.

The discussion arising from the notes on Chatham Island specimens of circum- Antarctic *Samolus repens* (*Veg. Chatham-Is.* 34-36) extends to commentaries on other taxa, and the fuller and new diagnosis for *Samolus valerandii* L., a plant he acknowledges as unknown in the New Zealand Botanical Region. In much the same way under the name of *Chiloglottis traversii* (*Veg. Chatham-Is.* 51) the expanded discussion includes a full description of the Victorian orchid *C. gunnii* Lindl. which he thought might be better treated as var. *viridiflora*. Mueller wrote digressively and as the Spirit moved him even to the point of recording Haast's gathering of *Phragmites australis* (*Arundo phragmites*) from the Grey River, Westland, as a native species, the first record of this plant in New Zealand.

(v) Taxa included by Mueller in widespread New Zealand taxa but recognized since 1864 as endemic

Among taxa discussed by Mueller as New Zealand-based indigenous plants, eleven have, since 1864, been segregated as Chatham Island endemics. In *Corokia* and *Pseudopanax* Kirk discerned new endemic species among those placed by Mueller in taxa of New Zealand-wide distribution.

Among these 11 entries the most dramatic is *Embergeria* — one of only two endemic genera of the Chathams. Its one species *E. grandiflora* is *Sonchus oleraceus* of the *Vegetation* (p. 31) = *S. grandiflora* Kirk. *Embergeria*, a genus distinct from *Sonchus* was erected by Boulos (1965); since its lectotypification by Lander (1976) it is treated as monotypic. It is not on the Snares Islands as Cheeseman (1880) stated.

In *Gentiana* Mueller advocated *G. saxosa* as a collective name for several described species (*Veg. Chatham-Is.* 40), but Cheeseman (1906) advanced the cause of the Chatham Island gentian in H.H. Travers' collection giving it an eponymous epithet.

Several species are the sole representative of their genus on the Chatham Islands viz. *Astelia chathamica, Corokia macrocarpa, Cortaderia turbaria, Gentiana chathamica [Chionogentias], Pseudopanax chathamicus.*

Geranium traversii Hook. f. was described from one small plant after Travers' specimens arrived at Kew; Mueller had included it in *G. dissectum* (*Veg. Chatham-Is.* 10).

Mueller could not have known that *Cyathodes acerosa* var. *latifolia* Hook. f. (*Veg. Chatham-Is.* 42) had a new name at species level as *C. robusta* in Hooker's *Handbook* (1864). Nor does it seem secure in *Cyathodes* which Weiller (1996a, b) restricts to Tasmania. *Cyathodes parviflora* has a curiously disjunct distribution — North Cape and Chatham Islands (Allan 1961) — which demands attention. *Dracophyllum arboreum* was distinguished from *D. scoparium* (*Veg. Chatham-Is.* 50) by Cockayne (1902); Wardle (1987) reduced *D. paludosum* Cockayne, described in 1902 as an endemic, to synonymy in *D. scoparium*, a proposition Cockayne himself thought possible.

These taxa are in Table 1 in the form *Corokia macrocarpa* Kirk 1899; *C. buddleioides* A. Cunn. (*Veg. Chatham-Is.* 16); **endemic**.

Endemic Taxa not listed by Mueller and described since 1864

I include a short list of endemics described since Travers' 1863 collections were examined by Mueller. I do so only to allow a check on island endemics, a topic considerably capturing biologists' imagination (Barrett 1996; Bramwell 1979). Mueller had newly described 12 endemic taxa, of which *Tetragonia implexicoma* var. *chathamica* and *Polypodium scandens* var. *billardierei* are no longer regarded as such.

Some few endemic taxa, unrelated to Mueller's interpretation of H.H. Travers' specimens, have been described in the last 135 years (Table 2). Some like *Olearia semidentata* var. *albiflora* Dorrien Smith, *O. chathamica* var. *dendyi* Cockayne, and *Juncus planifolius* var. *chathamicus* Buch., have not stood up to later scrutiny being submerged in their superior taxa. *Linum monogynum* var. *chathamicum* Cockayne is upheld as an endemic by Given (1996) but not by Allan (1961).

Disphyma papillatum Chinnock (1971) was based on specimens collected particularly by N. Simpson, Travers having lost his specimens, which included the widespread *D. australe*, to mildew. No blame can attach to Mueller. The remaining taxa are run of the mill — two species of *Hebe* accepted from four described by Cockayne, Buchanan, and Kirk in *Veronica. Festuca coxii* of coastal cliffs, and *Poa chathamica* of coastal rocks and inland dunes and peat, resulted from Cockayne's collections with F.A.D. Cox; Petrie (1902) who described both, at first placed *F. coxii* in *Agropyron*, a not unsurprising mistake.

The sole endemic fern, *Asplenium chathamense*, has since been described from among many recent specimens (Brownsey 1985), although it is thought that there are unnamed endemic species in *Polystichum* (Brownsey *et al.* 1985; Given 1996).

Two plants considered worthy of recognition are listed by Given (1996), viz. *Craspedia* "Chatham", and *Utricularia* "Southern Tablelands minute". Both await taxonomic attention.

The only serious omission from Mueller's list is *Sporadanthus traversii* (F. Muell.) Kirk; Dieffenbach had collected specimens in 1840 but Travers did not gather it in 1863 from its water-saturated habitat. Further material led Mueller (1874) to recognize the new restionaceous genus *Sporadanthus*, once thought endemic to the Chathams but known now in North Island peat bogs (Cheeseman 1880).

The mode of declaration of the new genus was unorthodox. In a letter to Dr James Hector, an extract of which was printed in the Proceedings of the New Zealand Institute, and not in the Transactions, Mueller wrote "... I have deemed it best to form a separate genus for the Chatham Island plant, and have named it *Sporadanthus*". He asked Hector to publish it. Fortunately for nomenclature he gave his earlier name — *Lepyrodia traversii* F. Muell.

Travers' Second Exploration 1871

H.H. Travers' second Chatham Islands' botanical exploration, this time sponsored by the Colonial Museum, began in July 1871 (Travers, W.T.L., 1872). The outcome was such that Hector (1873) could report that ten sets of H.H. Travers' specimens of "An almost exhaustive collection of the botany of the Chatham Islands ... will be available for exchange as soon as they have been reported on by Baron von Mueller, to whom a complete set has been sent in duplicate for this purpose".

Based on these specimens Mueller (1873) increased the number of genera present on the islands from 67 to 123 (almost double) and the number of species from 87 to 183 (more than double). These were distributed among (1) dicotyledons, 72 genera 94 species; (ii) monocotyledons, 34 genera, 52 species; (iii) ferns and allies, 17 genera 37 species; the genera were listed but not the species. Buchanan (1875) enumerating the taxa represented in H.H. Travers' specimens in the Colonial Museum, Wellington, which incorporated most of the genera in Mueller's second list, gave totals of 109 dicotyledonous species, 49 species of monocotyledons, and 47 species of ferns and allies, among which *Veronica chathamica* alone was described as new, and *Senecio radiolatus* reduced to varietal rank in *S. lautus*.

These large differences between the *Vegetation* and the outcome of the Travers' second trip indicate that the second collections greatly exceeded the first, not that Mueller was considerably selective in what he wrote up for the *Vegetation*.

There is room for discontent, however, over Mueller's failure to provide what Buchanan (1875) described as the "... complete analytical list of the whole", Hector (1873) having made it clear that specimens from Travers' 1871 journey had been sent to Mueller for that express purpose.

The "Enumeration" And Its Responses

Mueller's grasp of the taxonomy of the plants of the Chatham Islands that Travers had gathered was rapid, efficient, and highly successful. That the *Vegetation* with illustrations — seven plates with 89 individual drawings by F. Schönfeld — was published just more than a year after Travers set out on his exploration, and about five months after the specimens arrived at MEL, vouches for diligent application beyond modern expectation. The work was further characterized by the long lists of cited usages of species names and, especially, by long lists of synonyms for some taxa confirming his view that too many species had been described in the past. The ultimate was the much commented synonymy in *Veronica forsteri* nom. nov. The extent to which comparisons were made with related Australian taxa was uncharacteristic of treatment of New Zealand plants, then or perhaps since. Further, Mueller made extensive use of the collectors' field notes and diary, perhaps to compensate for never having been to the Islands, to complement his formal descriptions.

Hooker had written to Haast in 1864 of his hope "... that Mueller will not publish Travers' Chatham Island plants. He is so reckless and careless — he is an excellent, most assiduous, marvellous man, but craves to have *F. Muell.* after every name, and has loaded the Australian flora with endless synonyms, examining in

haste, describing with the utmost carelessness, and causing no end of trouble to his unlucky brother botanists. I tell him plainly that he is ruining his reputation, but nothing will stop him. He has made chaos of Australian botany." (J.D. Hooker to J. Haast 1864, *in* H.F. von Haast 1948). The implied risk was for New Zealand botany. That was in private correspondence. In public, by contrast, Hooker courteously wrote (1867, p. 722) "Two valuable contributions to New Zealand botany have been published since the first part of this Handbook appeared ....; the other is Dr Mueller's work 'On the Vegetation of Chatham Islands', founded chiefly on Mr W. (*sic*) Travers' collections". In Part II of the Handbook, Hooker under "Additions, Corrections, etc." acknowledged Mueller's *Vegetation* in entries such as those under *Hymenanthera crassifolia* (p. 724), *Colobanthus billardierei* (p.725), *Geranium traversii* n.sp. (p. 726), *Ligusticum dieffenbachii* (p. 729), *Olearia traversii* (p. 731), and *Cotula featherstonii* (p. 733).

Cockayne (1902), writing after his 1901 visit to the Islands, noted that Mueller provided descriptions or notes on 129 species of phanerogams and 25 species of ferns and lycopods. Cockayne's criticism was of the small number of species detected by Mueller, but by that time he had his own data and those from both of H.H. Travers' collections on which to base his opinion, aided by Buchanan (1875). Mueller with c.100 specimens of ferns and higher plants was not as well supplied in 1864.

Cheeseman (1906) wrote of the *Vegetation* that it was "... an important addition to the botanical literature of the colony ..." but that "... New Zealand botanists entirely repudiate the peculiar views entertained by the author respecting the circumscription of many of the species". Those botanists are unnamed but clearly included Cockayne, Darwinian in outlook, who had blamed Mueller's belief in the fixity of species which resulted in a restricted number of taxa. Mueller (1864, p. 8) seems to have been Linnaean in the sense expressed in the Philosophia Botanica "*Species tot numeramus quot diversae formae in principio sunt creatae*". Mueller's attitude to the "... theory of transmutation ..." is clear in his Annual Report of the Government Botanist and Director of the Botanic Garden Melbourne, 1865. There, writing explicitly of the *Vegetation* he stated that "... in the treatise under consideration I have expressed though cursory still unequivocally a dissenting opinion." Mueller there also complained that taxonomists, through their lack of extensive field studies, vainly attempted "... to draw lines of specific demarcation between mere varieties or races, ..." (shades of a later Cockayne dictum). Mueller used the *Vegetation* as an anti-Darwinian polemic.

Without denying Cheeseman's (1906) opinion of the "peculiar views" in the well discussed and almost incredible *Veronica forsteri* episode, or of *Epilobium tetragonum* from which six taxa are now recognized, but denying his opinion that it applied to "many species", my own conclusion is that Mueller, under the heading "Enumeration of the Plants of the Chatham-Islands", presented a competent work in botanical science although written in an eclectic style, illustrated with seven plates, and extensive in its notes and appreciations compared with the style of his contemporary J.D. Hooker. The eight new endemic species he described have stood the test of time, and 130 years later their number is not much increased. The concordant historic usages of names were present, the synonymy apparent, and the ecology carefully attributed to H.H. Travers together with the use of his notes on habit and form. Nowhere do I find for these Chatham Island taxa evidence of loading the "... flora with endless synonyms" or describing with "utmost carelessness" (J.D. Hooker 1864 in H.F. von Haast 1948). Quite the opposite to judge from the consequences. My difficulties lie in the Teutonic diction and the problems it generates, the curious and often unrelated digressions, and the fulsome dedication to Irish-born W.T.L. Travers where the "utmost carelessness" lies in the attribution to Travers of a Judgeship of the Supreme Court whereas he had been a District Court Judge before entering politics.

Hooker (1867), despite an earlier unease expressed to Haast, immediately used the *Vegetation* to the benefit of New Zealand taxonomic botany. Mueller, who expected that his views and Hooker's on the Chatham Islands flora would "... in many instances ..." coincide (*Vegetation* p. 4), was justified. The exceptions are evident. In a letter to Haast (24 October 1864) just after the publication of the *Vegetation*, Mueller remarked that more effort was invested in his small book that was apparent at a first glance. *Vero!*

Apart from its essential taxonomic and nomenclatural uses Mueller's *Vegetation* has not earned the significant reputation in New Zealand that I believe it merits.

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The late Dr J.H. Willis of MEL introduced me to Baron von Mueller during my first visit to the Herbarium in 1951; my interest reflects the enthusiasm he displayed then. I was pleased to take part in "The Scientific Savant in 19th Century Australia" at the University of Melbourne in September 1996 with the life, times, and legacy of Ferdinand von Mueller as the central theme. That no mention was made of his *Vegetation of the Chatham-Islands* has prompted this appreciation.

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Weiller, C.M. (1996a). Reinstatement of the genus *Androstoma* Hook. f. (Epacridaceae) *New Zealand Journal of Botany* **34**, 179–189.
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Table 1: Chatham Island taxa in Mueller's "Enumeration"; current name listed first.

Dicotyledons

Aciphylla dieffenbachii (F. Muell.) Kirk 1899; as *Gingidium dieffenbachii* F. Muell. (*Veg. Chatham-Is. Chatham-Is.* 17, t.1); **endemic**.
A. traversii (F. Muell.) Hook. f. 1867; as *Gingidium traversii* F. Muell. (*Veg. Chatham-Is.* 18); **endemic**.
Avicennia officinalis L. (*Veg. Chatham-Is.* 75); leg. E. Dieffenbach; unknown on Chatham Islands.
Brachyglottis huntii (F. Muell.) Nordenstam 1978; as *Senecio huntii* F. Muell. (*Veg. Chatham-Is.* 23, t.3); **endemic**.
Calystegia sepium R.Br. (*Veg. Chatham-Is.* 38).
C. soldanella R.Br.; in synonymy of *C. sepium*.
C. tuguriorum (G. Forst.) Hook. f.; in synonymy of *C. sepium*.
Colobanthus muelleri Kirk 1895; as *Colobanthus billardierei* var. *bachypoda* F. Muell. (*Veg. Chatham-Is.* 11).

Coprosma sp. (*Veg. Chatham-Is.* 18) "... two species most probably of this genus ..." Under *C. propinqua* A. Cunn. leg. Dieffenbach, Mueller stated "Probably one of the species found by Mr Travers is referable to this plant" (*Veg. Chatham-Is.* 75). *C. propinqua* var. *martinii* W.R.B. Oliver is **endemic**.

Coriaria arborea Lindsay 1868; as *C. ruscifolia* L. (*Veg. Chatham-Is.* 11)

Corokia macrocarpa Kirk 1899; as *C. buddleioides* A. Cunn. (*Veg. Chatham-Is.* 16); **endemic**.

Corynocarpus laevigatus J.R. & G. Forst. (*Veg. Chatham-Is.* 14).

Cyathodes robusta Hook. f. 1864; as *C. acerosa* var. *latifolia* Hook f. (*Veg. Chatham-Is.* 43), leg. Capt. Anderson; **endemic**.

C. parviflora (Andr.) Allan 1961; as *Leucopogon richei* R.Br. (*Veg. Chatham-Is.* 45).

Disphyma papillatum Chinnock 1971; Mueller (*Veg. Chatham-Is.* 13) refers to specimens of *Mesembyranthemum* which Travers had lost; **endemic**; *D. australe* (Aiton) N.E. Br. is present (Chinnock 1971).

Dracophyllum scoparium Hook. f. (*Veg. Chatham-Is.* 42); including *D. paludosum* Cockayne 1902.

Embergeria grandifolia (Kirk) Boulos 1965; as *Sonchus oleraceus* L. (*Veg. Chatham-Is.* 31); **endemic**.

Epilobium alsinoides ssp. *atriplicifolium* (A. Cunn.) Raven & Engelhorn 1971; in synonymy of *E. tetragonum* L. (*Veg. Chatham-Is.* 15) together with the four following taxa.

E. billardieranum Sér. ssp. *billardieranum*.

E. billardieranum ssp. *cinereum* (A. Rich.) Raven & Engelhorn 1971.

E. pallidiflorum A. Cunn.

E. pubens A. Rich.

E. rotundifolium G. Forst.

Euphorbia glauca G. Forst. (Veg. Chatham-Is. 17) "A plant of this genus was observed in the Chatham-Islands by Mr Travers. It is most likely *Euphorbia glauca* ..."; specimen lost through mildew according to Travers (1869).

Gentiana chathamica Cheeseman 1906 as *G. saxosa* G. Forst. (*Veg. Chatham-Is.* 40); **endemic**.

Geranium traversii var. *elegans* Cockayne 1867; as *G. dissectum L.* (*Veg. Chatham-Is.* 10); **endemic**.

Hebe dieffenbachii (Benth.) Cockayne & Allan 1926; included in *V. forsteri* F. Muell. (*Veg. Chatham-Is.* 45) as a synonym; leg. E. Dieffenbach, **endemic**.

Leptinella featherstonii F. Muell. (*Veg. Chatham-Is.* 27, t.5); **endemic**.

L. potentillina F. Muell. (*Veg. Chatham-Is.* 28 t.6).

Linum monogynum G. Forst. (*Veg. Chatham-Is.* 10).

Lobelia anceps Thunb. (*Veg. Chatham-Is.* 31).

Macropiper exselsum (G. Forst.) Miquel subsp. *excelsum* (*Veg. Chatham-Is.* 48).

Melicytus chathamicus (F. Muell.) Garn.-Jones 1988; as *Hymenanthera latifolia* var. *chathamica* F. Muell. (*Veg. Chatham-Is.* 9); **endemic**.

Muehlenbeckia australis (G. Forst.) Meissner (*Veg. Chatham-Is.* 50).

Myosotidium hortensia (Decne) Baill. 1891; as *M. nobile* Hook. (*Veg. Chatham-Is.* 32); **endemic**.

Myrsine chathamica F. Muell. (*Veg. Chatham-Is.* 38, t.7); **endemic**.

Myoporum laetum G. Forst. (*Veg. Chatham-Is.* 32).

Olearia chathamica Kirk 1891; Mueller as "...evidently allied to *Eurybia [Olearia] operina*" (*Veg. Chatham-Is.* 22); **endemic**.

O. semidentata Hook. f.; as *Eurybia semidentata* (Decne) F. Muell. (*Veg. Chatham-Is.* 21); **endemic**.

O. traversii (F. Muell.) Hook. f. 1867; as *Eurybia traversii* F. Muell. (*Veg. Chatham-Is.* 19, t.2); **endemic**.

Pimelea arenaria A. Cunn. (*Veg. Chatham-Is.* 48).

Plagianthus regius var. *chathamicus* Cockayne 1912; as *P. betulinus* A. Cunn. (*Veg. Chatham-Is.* 10); **endemic**.

Polygonum decipiens R.Br.; in synonymy of *P. minus* Huds. (*Veg. Chatham-Is.* 49).

Potentilla anserinoides Raoul; in synonymy of *P. anserina L.* (*Veg. Chatham-Is.* 14).

Pseudopanax chathamicus Kirk 1899; as *Hedera crassifolia* A. Gray (*Veg. Chatham-Is.* 75); leg. E. Dieffenbach; **endemic**.

Samolus repens (J.R. & G. Forst.) Pers. (*Veg. Chatham-Is.* 34).

Seneco radiolatus F. Muell. ssp. *radiolatus* (*Veg. Chatham-Is.* 24, t.4); **endemic**.

Sophora microphylla Art.; in synonymy of *Edwardsia grandiflora* Salisb. (*Veg. Chatham-Is.* 13). Specimens lost (Travers 1869).
Solanum aviculare G. Forst. (*Veg. Chatham-Is.* 31).
Taraxacum officinale Weber (*Veg. Chatham-Is.* 30); introduced.
Tetragonia trigyna Hook. f. 1864; as *T. implexicoma* var. *chathamica* F. Muell. (*Veg. Chatham-Is.* 12).
Urtica australis Hook. f.; as *U. incisa* Poir. (*Veg. Chatham-Is.* 47).

Monocotyledons

Aporostylis bifolia (Hook. f.) Rupp & Hatch 1946; as *Chiloglottis traversii* F. Muell. nom. nov. pro *Caladenia bifolia* Hook. f. (*Veg. Chatham-Is.* 51).
Astelia chathamica (Skottsb.) L.B. Moore 1966; as *A. banksii* A. Cunn. (*Veg. Chatham-Is.* 54); **endemic**.
Austrofestuca littoralis (Labill.) E. Aleks 1976; as *Festuca littoralis* Labill. (*Veg. Chatham-Is.* 59).
Carex sectoides (Kirk) Edgar 1970; as *C. paniculata L.* (*Veg. Chatham-Is.* 57).
C. ventosa C.B. Clarke 1906; as *C. forsteri* Wahl. (*Veg. Chatham-Is.* 58); **endemic**.
Cortaderia turbaria Connor 1987; as *Arundo conspicua* G. Forst. (*Veg. Chatham-Is.* 61); **endemic**.
Demoschoenus spiralis (A. Rich.) Hook. f. (*Veg. Chatham-Is.* 57).
Deschampsia caespitosa (L.) Beauv.; in synonymy of *Aira caespitosa L.* (*Veg. Chatham-Is.* 61).
Earina mucronata Lindl. (*Veg. Chatham-Is.* 50).
Eleocharis acuta R.Br..
E. gracilis R.Br.; in synonymy of *Heleocharis palustris* R.Br. (*Veg. Chatham-Is.* 56).
Holcus lanatus L. (*Veg. Chatham-Is.* 61); naturalized.
Juncus planifolius R.Br. (*Veg. Chatham-Is.* 56).
Lachnagrostis filiformis (G. Forst.) Trin.; in synonymy of *Agrostis solandri* F. Muell. (*Veg. Chatham-Is.* 60).
Libertia peregrinans Cockayne & Allan 1926; as *L. ixioides* Sprengel (*Veg. Chatham-Is.* 53).
Luzula banksiana var. *acra* Edgar 1966; in synonymy of *L. campestris* DC. (*Veg. Chatham-Is.* 55).
Phormium tenax J.R. & G. Forst. (*Veg. Chatham-Is.* 54); referred to as *P. aff. tenax* "Chathams" by Given (1996); **endemic**.
Pterostylis banksii var. *silvicultrix* F. Muell. (*Veg. Chatham-Is.* 51); **endemic**.
Rhipogonum scandens J.R. & G. Forst. (*Veg. Chatham-Is.* 54).
Rhopalostylis sapida Wendle & Drude 1878; as *Areca sapida* G. Forst. (*Veg. Chatham-Is.* 55); Cockayne (1902) emphatically stated that these plants are not *R. sapida*; Given (1996) refers them to *Rhopalostylis* "Chatham" and **endemic**.

Pteridophytes

* *Adiantum cunninghamii* Hook.; as *A. formosum* var. *cunninghamii* (Hook.) F. Muell. (*Veg. Chatham-Is.* 72).
* *Asplenium bulbiferum* G. Forst. ssp. *bulbiferum*; as *A. marinum* var. *bulbifera* (G. Forst.) F. Muell. (*Veg. Chatham-Is.* 66).
* *A. flaccidum* G. Forst. ssp. *flaccidum*; as *A. marinum* var. *flaccida* (G. Forst.) F. Muell. (*Veg. Chatham-Is.* 67).
* *A. obtusatum* G. Forst. ssp. *obtusatum*; as *A. marinum* var. *obtusata* (G. Forst.) F. Muell. (*Veg. Chatham-Is.* 66).
A. polyodon G. Forst.; in synonymy of *A. falcatum* Lam. (*Veg. Chatham-Is.* 65).
Blechnum sp. (*B. capense sensu* Allan 1961); as *Lomaria capense* Willd. (*Veg. Chatham-Is.* 72).
B. discolor (G. Forst.) Keys. 1873; as *Lomaria discolor* (G. Forst.) Willd. (*Veg. Chatham-Is.* 71).
* *Botrychium australe* R.Br.; in synonymy of *B. ternatum* Swartz (*Veg. Chatham-Is.* 63).
Ctenopteris heterophylla (Labill.) Tindale 1957; as *Polypodium grammitidis* R.Br. (*Veg. Chatham-Is.* 68).

Cyathea cunninghamii Hook. f. (*Veg. Chatham-Is.* 65).
C. dealbata (G. Forst.) Swartz (*Veg. Chatham-Is.* 65).
Dicksonia squarrosa (G. Forst.) Swartz (*Veg. Chatham-Is.* 65).
Gleichenia microphylla R.Br.; as *G. dicarpa* (*Veg. Chatham-Is.* 62).
Histiopteris incisa (Thunb.) J. Smith 1875; as *Pteris incisa* Thunb. (*Veg. Chatham-Is.* 74); leg. Capt. Anderson.
Hymenophyllum demissum (G. Forst.) Swartz (*Veg. Chatham-Is.* 64).
* *Hypolepis lactea* Brownsey & Chinnock 1984 p.p.
* *H. rufobarbata* (Col.) Wakef. 1956 p.p.; as *Polypodium rugosulum* Labill. (*Veg. Chatham-Is.* 68).
* *Lastreopsis microsora* ssp. *pentangularis* (Col.) Tindale 1965; as *Nephrodium decompositum* R.Br. (*Veg. Chatham-Is.* 69).
Lycopodium deuterodensum Herter 1949; as *L. densum* Labill. (*Veg. Chatham-Is.* 62); leg. E. Dieffenbach.
* *L. varium* R.Br.; as *L. selago* var. *flagellaria* (A. Rich.) F. Muell. (*Veg. Chatham-Is.* 62); "requires further study" (Brownsey *et al.* 1985).
L. volubile G. Forst. (*Veg. Chatham-Is.* 62).
Paesia scaberula (A. Rich) Kuhn; in synonymy of *Pteris scaberula* A. Rich. (*Veg. Chatham-Is.* 73).
* *Phymatosorus pustulatus* (G. Forst.) Large, Braggins & P.S. Green 1992; as *Polypodium scandens* var. *billardieriei* (R.Br.) F. Muell. (*Veg. Chatham-Is.* 69).
Pneumatopteris pennigera (G. Forst.) Holttum 1973; as *Polypodium pennigerum* G. Forst. (*Veg. Chatham-Is.* 68).
* *Polystichum vestitum* (G. Forst.) C. Presl; as *Aspidium aculeatum* Swartz (*Veg. Chatham-Is.* 70).
* *Pteridium esculentum* (G. Forst.) Cockayne 1908; as *Pteris aquilina* L. (*Veg. Chatham-Is.* 73); leg. Capt. Anderson.
Rumohra adiantiformis (G. Forst.) Ching 1934; as *Aspidium coriaceum* Swartz (*Veg. Chatham-Is.* 70).
Trichomanes venosum R.Br. (*Veg. Chatham-Is.* 64).
* Particularly mentioned in Brownsey et al. (1985).

Table 2. Endemic Chatham Islands taxa described from later collections and currently accepted

Asplenium chathamense Brownsey
Callitriche petriei ssp. *chathamicus* R. Mason
Carex chathamica Petrie
Coprosma chathamica Cockayne
Disphyma papillatum Chinnock; Mueller (*Veg. Chatham-Is.* 13) referred to specimens of *Mesembryanthemum* which Travers had lost.
Dracophyllum arboreum Cockayne
Festuca coxii (Petrie) Hack.
Hebe barkeri (Cockayne) Cockayne (includes *H. gigantea* (Cockayne) Cockayne & Allan).
H. chathamica (Buchan.) Cockayne & Allan (includes *H. coxiana* (Kirk) Cockayne).
Olearia chathamica Kirk 1891; *O. operina* Hook. f. "form with lax bracts on the scapes". Mueller (p. 22) discussed this taxon as "evidently allied to *Eurybia [Olearia] operina* ..."
Poa chathamica Petrie

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Batrachospermum latericium sp. nov. (Batrachospermales, Rhodophyta) from Tasmania, Australia, with New Observations on *B. atrum* and a Discussion of Their Relationships

Timothy J. Entwisle and Helen J. Foard

Royal Botanic Gardens Melbourne, Birdwood Ave, South Yarra, Vic. 3141, Australia

Abstract

Batrachospermum latericium sp. nov. occurs in humic streams in the Southwest National Park in Tasmania and is thus far collected from New Harbour to the Old River catchment. Like *B. diatyches* Entwisle, also a Tasmanian endemic, the thallus of the new species has brick-like rhizoidal filament cells and a large apical cell. The primary fascicles, however, are more like those of *B. puiggarianum* Grunow from South America and Africa. New character states, including the sporadic occurrence of spermatangia on involucral bracts and 'shortly indeterminate' gonimoblast filaments, are reported for the widespread *B. atrum* (Hudson) Harvey. There is no support for the recognition in Australia or New Zealand of the recently described *B. androinvolucrum* Sheath *et al.*, characterized by the production of spermatangia exclusively on involucral filaments. In an exemplar cladistic analysis based on morphological characters, taxa included currently in the section *Setacea* formed a monophyletic clade and within this, the two Australian endemics were sister taxa. Brick-like rhizoidal filament cells, a large thallus apical cell and shortly indeterminate gonimoblast filaments are derived character states within Batrachospermales.

Introduction

The setaceous species of *Batrachospermum* (section *Virescentia p.p.*; = section *Setacea sensu* Sheath *et al.* 1993a) from Australia and New Zealand were revised six years ago (Entwisle 1992). Since that revision, a new species has been discovered in Tasmania, additional collections of *B. atrum* (Hudson) Harvey have revealed more character variation within that taxon, and a revision of North American representatives of this group has been published by Sheath *et al.* (1993a). The description of the Tasmanian species and an analysis of new data are presented here in advance of a complete account of the order Batrachospermales for the *Algae of Australia* series (see also Entwisle and Foard 1997). A cladistic analysis based on morphological characters is used to assess the monophyly of the section *Setacea* (considered to be part of *Virescentia* by Necchi and Entwisle 1990), and to study the distribution of brick-like rhizoidal filament cells, large thallus apical cells and shortly indeterminate gonimoblast filaments in the Batrachospermales.

Methods

Preparation of Material

Specimens were preserved initially in 5% commercial formalin or, less suitably for microscopic examination, in 70% ethanol. After preparing dried specimens and permanent microscope mounts, the remaining material was transferred to 70% ethanol with 5% glycerol. Microscope preparations were stained with 1% aniline blue (with 4% HCl) and mounted in 10% *Karo* corn syrup (and 0.25% phenol), with 40% *Karo* corn syrup (and 0.25% phenol) added to the side of the coverslip during drying

Cladistics

The data matrix was constructed using Dada (Nixon 1995) and run in Nona (Goloboff 1993) with the 'multi*' option. Random addition sequences were run 35 times holding 35 trees at each run. The shortest trees were examined using Clados (Nixon 1994).

Data were taken from the series of revisions published by R.G. Sheath, M.L. Vis, K.M. Cole and co-authors (Kaczmarczyk *et al.* 1992; Sheath *et al.* 1993b, 1994b; Vis and Sheath 1992; see Entwisle, 1998, for *Batrachospermum* references) because their species concepts match those used in the previously published molecular analysis of this group (Vis *et al.* 1998). Representative material in MEL was also examined.

Descriptions of Species

1. *Batrachospermum latericium* Entwisle sp. nov.

a *B. puiggariano* Grunow cellulis filamentarum rhizoidalium lateriformibus (8–15 µm diametro), cellula apicali thalli largiore (11–15 µm diametro), carposporangiis largioribus (20–26 µm longo, 16–18 µm diametro), et trichogynio obovoideo ad fusiformem differt; a *B. atro* (Hudson) Harvey proprietatibus omnibus praecedentibus et verticillibus reductis maxime (plerumque bicellularibus) ad axem centralem adhaerentem differt; a *B. diatychite* Entwisle fasciculis primariis brevioribus, ad septum constrictum et cellula apicali thalli per fasciculos protrusum differt. Figs 1, 2A

Type: Tasmania, Southwest National Park, Old River, first major riffle above Bathurst Harbour, *Entwisle 2507*, 4.iii.1996 (holotype MEL; isotype HO).

Thallus firm, monopodial, 1–5 cm long, olive-green; apices acute, apical cell 6–12 µm long, 11–15 µm in diameter, protruding through primary fascicles.

Fascicle whorls conical, very small and often barely rising above rhizoidal filaments, 99–180 µm in diameter, separated; internodes 120–170 µm in long. *Axis* colourless, axial cells 40–80 µm in diameter, rhizoidal filament cells brick-like, 7–12 µm long, 8–15 µm in diameter, narrow secondary rhizoidal filaments (cells 10–16 µm long, c. 6 µm in diameter) sometimes present between primary rhizoidal filaments in older thalli; first fascicle initials produced 1–4 cells proximal to apex (2-celled fascicles present 4–6 cells proximal to apex). *Secondary fascicles* either a single cell cut-off from primary rhizoidal filament or a short filament arising from secondary rhizoidal filament. *Primary fascicles* 2 or 3 per pericentral cell, of 2(–4) cell storeys, branching absent or once-dichotomous; proximal cell obovoid (to globose), c. 8 µm long, c. 8 µm in diameter; distal cells globose (to hemispherical or dome-shaped), 6–10 µm long, c. 6 µm in diameter; hairs common in young part of thallus, up to 12 µm long. *Monosporangia* absent.

Monoecious (but individuals usually either predominantly male or female). *Spermatangia* borne on primary and secondary fascicles, clustered, globose, c. 8 µm in diameter. *Carpogonia* borne on (or in place of) primary fascicles, 1–2 cells from periaxial cell, subtending cells 4–5 µm long, 6–8 µm in diameter, scarcely modified; involucral filaments arising from all subtending cells, not extending beyond carpogonium, 1–2 cells long; carpogonium more or less straight, c. 22–24 µm long, base symmetrical or slightly oblique, c. 6 µm in diameter, trichogyne sessile, obovoid to fusiform, 7–10 µm in diameter at broadest part. *Carposporophytes* 1 per whorl, exserted from whorl, semi-globose, compact, c. 160 µm in diameter (c. 6 times whorl radius), centred on node; gonimoblast filaments 2–3 cells long; post-fertilisation cells of carpogonial branch obscure; carposporangia obovoid or globose, 20–26 µm long, 16–18 µm in diameter.

Chantransia rarely observed, sparsely branched; cells cylindrical, 38–56 µm long, 8–10 µm in diameter.

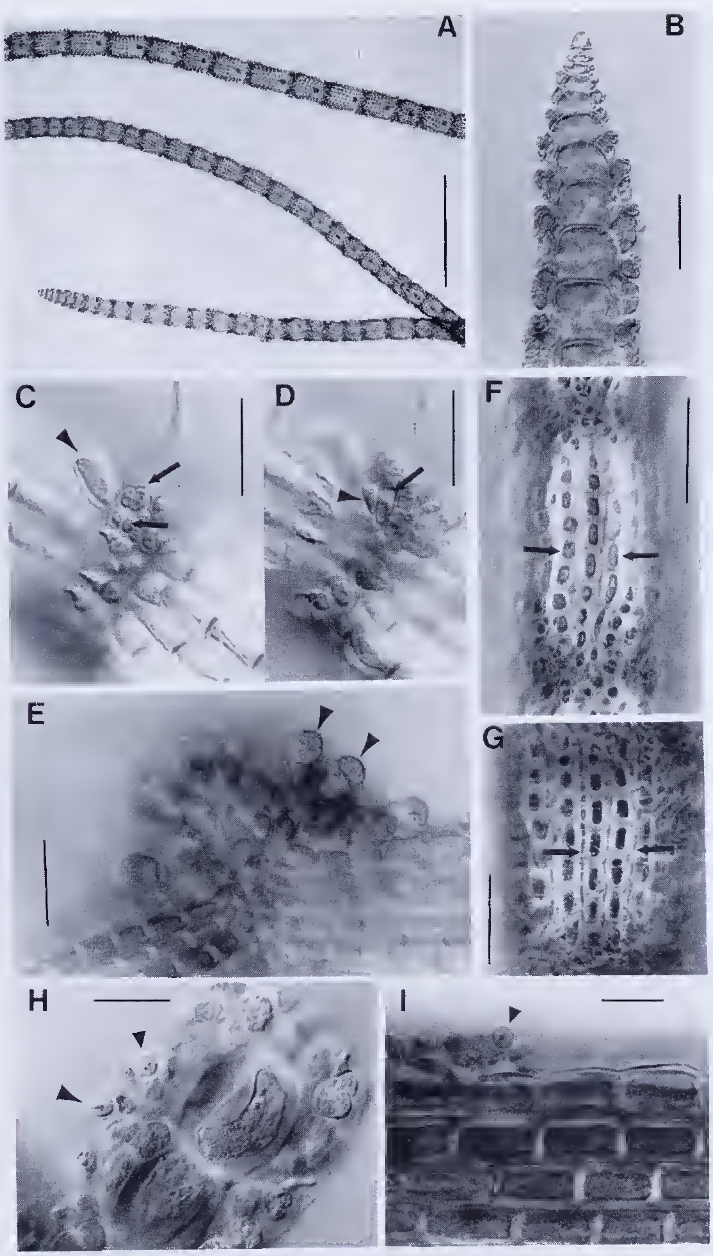

Fig. 1. *Batrachospermum latericium* Entwisle & Foard sp. nov. **A** thallus showing reduced whorls and regular rhizoidal filament cells (*Entwisle 2534*). Scale: 1400 µm. **B** apex showing fascicle initiation and structure (*Entwisle 2534*). Scale: 150 µm. **C** nodal region of thallus showing trichogyne (arrowhead), involucral bracts (arrows) and reduced fascicles (*Entwisle 2547*). Scale: 150 µm. **D** same as C but focusing on the base of the carpogonium (arrowhead) and carpogonial branch (arrow). Scale: 150 µm. **E** gonimoblast with carposporangia (arrowheads) (*Entwisle 2547*). Scale: 150 µm. **F** brick-like rhizoidal filament cells (arrows) (*Entwisle 2534*). Scale: 200 µm. **G** brick-like rhizoidal filament cells and narrow secondary rhizoidal filaments (arrows) in older part of thallus (*Entwisle 2534*). Scale: 200 µm. **H** spermatangia (arrowheads) on primary fascicles in young part of thallus (*Entwisle 2507*). Scale: 100 µm. **I** spermatangia (arrowhead) on secondary fascicle (older part than H) arising from brick-like rhizoidal cells (*Entwisle 2507*). Scale: 50 µm.

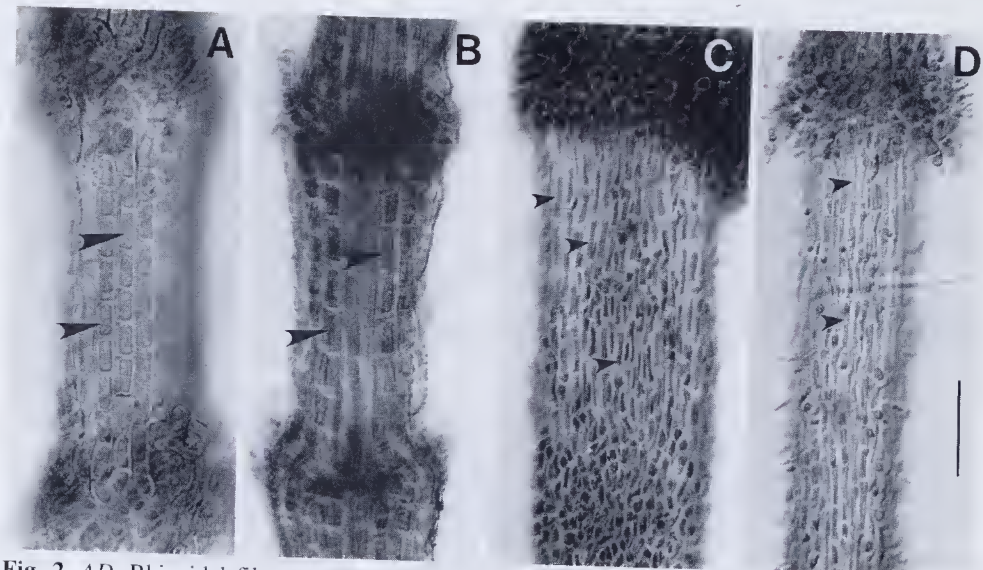

Fig. 2. *AD*, Rhizoidal filaments in four *Batrachospermum* species (Section *Virescentia*). Scale 200 μm. *Batrachospermum latericium* (**A**) and *B. diatyches* (**B**) with comparatively broad, brick-like rhizoidal filaments (large arrowheads); *B. puiggarianum* (**C**) and *B. atrum* (**D**) with cylindrical rhizoidal filaments.

Diagnostic Features

Batrachospermum latericium differs from *B. puiggarianum* Grunow (Fig. 2C) by having brick-like rhizoidal filament cells which are 815 μm in diameter (cf. 4 μm in diameter), a large thallus apical cell (11–15 μm cf. c. 7 μm in diameter), larger carposporangia (20–26 μm long and 16–18 μm in diameter cf. 8–13 μm long and 6–11 μm in diameter) and an obovoid to fusiform trichogyne (cf. club-shaped to ellipsoid). It differs from *B. atrum* (Figs 2D, 3) in all of the above features and by having extremely reduced whorls (usually 2 cells cf. 3–6 cells long) closely adherent to the central axis. *Batrachospermum diatyches* (Fig. 2B) has similar apical cells and rhizoidal filaments to *B. latericium* but the fascicles of that species consist of 4–6 cells in a tapering filament without constrictions at the cross-walls, and the thallus apical cell is overtopped by fascicles.

Distribution and Habitat

Batrachospermum latericium is restricted to streams in the far south-west corner of Tasmania, sometimes occurring with *B. atrum*. The streams are all humic-rich (tea-coloured) and flow through Button Grass (*Gymnoschoenus sphaerocephalus*) heath and cool temperate rainforest.

Etymology

From the Latin *latericium* (= brickwork), referring to the regular arrangement of rhizoidal filament cells diagnostic of this species and fellow Tasmanian endemic *B. diatyches*.

Other Specimens Examined

Tasmania: Southwest National Park: waterfall in New Creek, flowing off E side of SW Cape Ra., New Harbour, *Entwisle 2547*, 7.iii.1996 (MEL, HO); creek c. 1 km NNW of Smoke Signal Hill, first creek crossed on South Cape Track from New Harbour to Melaleuca, *Entwisle 2556*, 6.iii.1996 (MEL, HO); waterfall in creek flowing NNW from Harrys Bluff, c. 1 km SE of confluence with Old River, *Entwisle 2543*, 6.iii.1996 (MEL, HO); same creek as previous but in small water drop near confluence with Old River, *Entwisle 2534*, 6.iii.1996 (MEL, HO).

Notes

Although the reduced whorls are superficially similar to *B. puiggarianum*, the thallus apical cell and rhizoidal filaments of *B. latericium* are similar to those of *B. diatyches*. In addition, *B. latericium* and *B. diatyches* are restricted to cool temperate habitats in Tasmania, while *B. puiggarianum* is know only from tropical to subtropical South America and Africa (Necchi 1990a, Sheath *et al.* 1993a). The cladogram presented below indicates a possible relationship between these taxa.

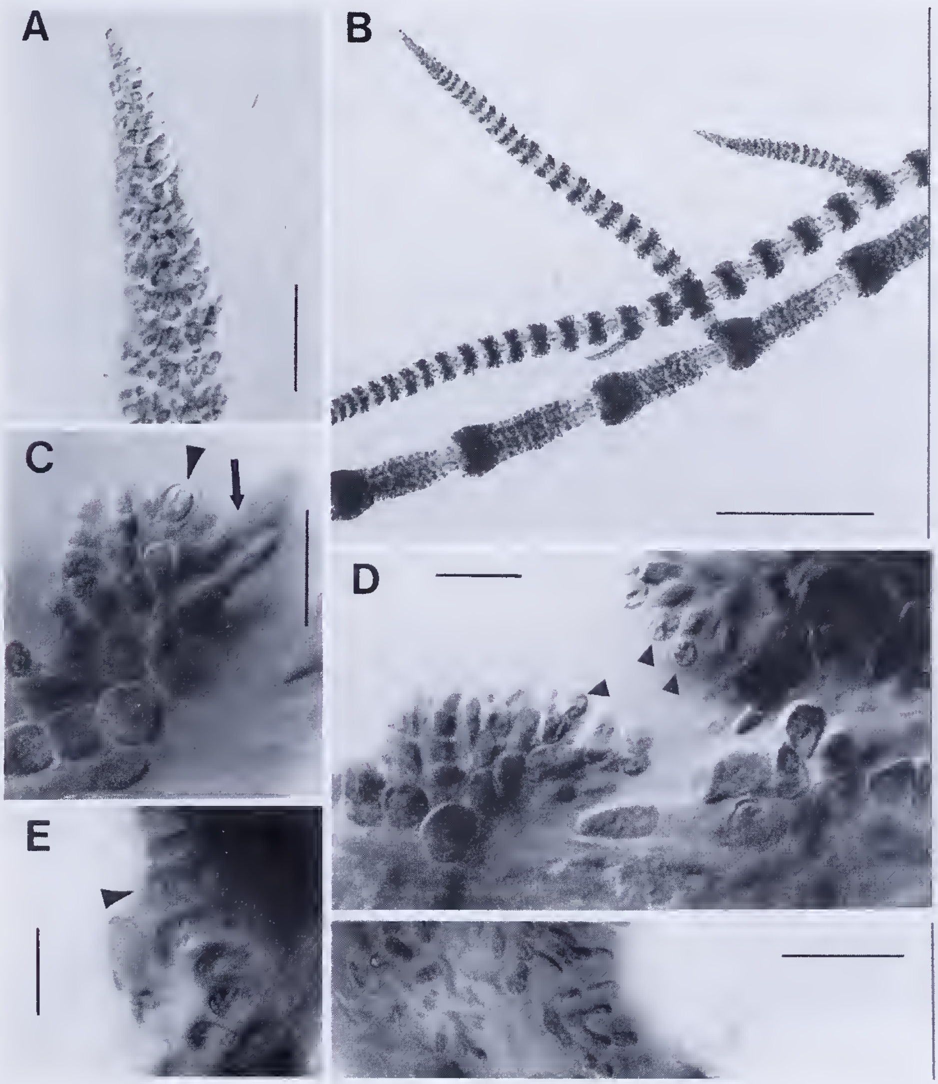

Fig. 3. *Batrachospermum atrum*. **A** apex of thallus showing fascicle initiation and hairs (*Entwisle 2520*). Scale: 150 µm. **B** thallus showing comparatively well developed whorls (*Entwisle 2516*). Scale: 1000 µm. **C** carpogonial branch showing spermatangia (arrowhead) on involucral bracts and carpogonium (arrow) (*Entwisle 2233*). Scale: 50 µm. **D** spermatangia on primary fascicles (arrowheads) (*Entwisle 2233*). Scale: 50 µm. **E** indeterminate gonimoblast filaments (arrows) extending beyond determinate portion of gonimoblast (arrowhead) (*Entwisle 39*). Scale: 50 µm. **F** indeterminate gonimoblast filaments extending along internodal region of thallus (arrows) (*V. Stout* [*S1*]). Scale: 100 µm.

2. *Batrachospermum atrum* (Hudson) Harvey

Additions to the description in Entwisle (1992, p. 430): internodes 160–1100 µm long; rhizoidal filaments 3–9(–21) µm in diameter, sometimes inflated; secondary fascicles sometimes absent; spermatangia borne on involucral filaments as well as on primary or secondary fascicles and sometimes on specialised fascicles, occasionally extremely profuse; carpogonial branches borne on (or in place of) secondary fascicles (as well as primary fascicles), carpogonia straight or curved, sometimes only 11–14 µm or up to 60 µm long, trichogyne to 11 µm wide in broadest part; carposporophyte up to 230 µm in diameter, occasionally borne internodally; gonimoblast filaments sometimes shortly indeterminate (i.e. they extend a short distance along the axis away from the primary carposporophyte mass); centre of carposporophyte sometimes distant from axis in older thalli.

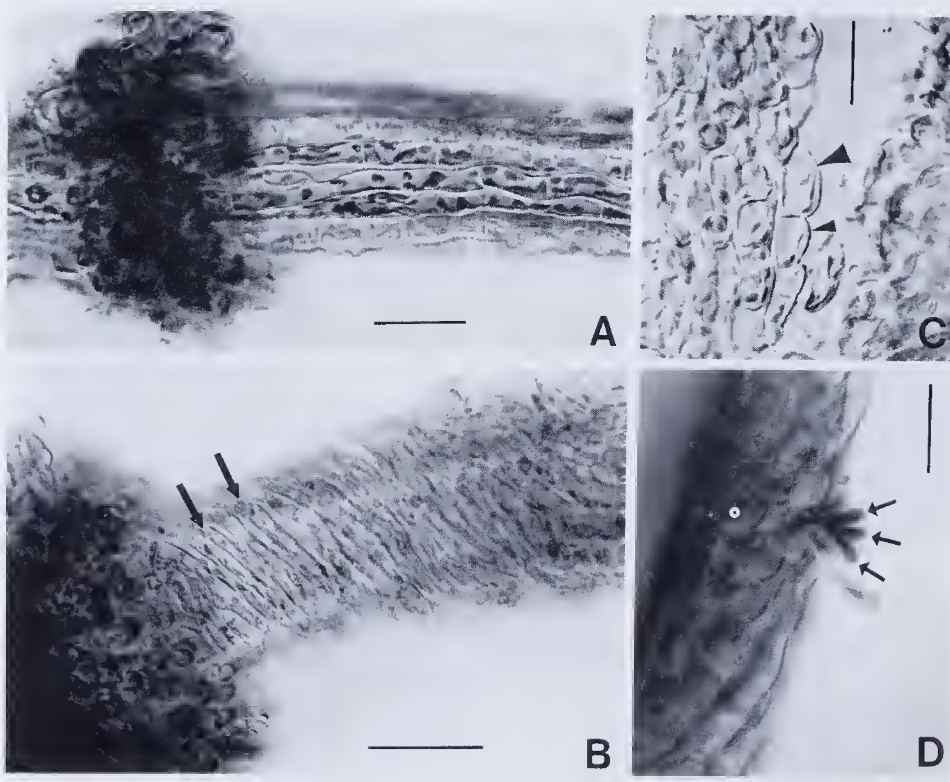

Fig. 4. *Batrachospermum atrum* (Lake Mountain variant) (*Entwisle 2445*). **A** younger portion of thallus with cylindrical rhizoidal filaments. Scale: 200 µm. **B** spiralling rhizoidal filaments (arrows). Scale: 200 µm. **C** squashed portion of thallus showing inflated rhizoidal cells (arrowheads). Scale: 100 µm. **D** internodal carpogonial branch (arrowhead) with involucral bracts terminated by elongate cells (arrows). Scale: 100 µm.

Selected Specimens Examined[1]

Western Australia: Beedelup Falls, c. 16 km W of Pemberton, *Entwisle 2403*, 6.i.1994 (MEL, PERTH); Frankland River, Hazelvale, *Entwisle 2397*, 6.i.1994 (MEL, PERTH); South Dandalup River, Torrens Road, c. 14 km NEE of Pinjarra, *Entwisle 2381*, 5.i.1994 (MEL, PERTH). **Queensland:** Running Creek, Kilcoy-Beerwah Road crossing, 2 km NE of Stanmore, *Entwisle 2232*, 6.ix.1993 (MEL, BRI). **Tasmania:** creek into Bathurst Harbour, W side of channel S of Forest Lagoon, *Entwisle 2516 and 2520*, 4.iii.1996 (MEL, HO); creek into New Harbour, W of New Creek, *Entwisle 2553*, 7.iii.1996 (MEL, HO); tributary of Great Forester River, Scottsdale-Derby Road, c. 8 km E of Scottsdale, *Entwisle 2625*, 12.iv.1996 (MEL, HO). **Victoria:** Delegate River (West Branch), Gunmark Road, 4.5 km from Gap Road, *Entwisle 2133, P.Y. Ladiges, G. Nelson and R. Raleigh*, 8.i.1992; (MEL); creek flowing through Echo Flat, near Helicopter Flat, Lake Mountain, *Entwisle 2445*, 30.xii.1994 (MEL).

Notes

Inflated Rhizoidal Filament Cells: Young portions of some thalli from Barren Grounds (New South Wales; *Entwisle 1566*) and Beedelup Falls (Western Australia; *Entwisle 2403*) have rhizoidal filament cells somewhat inflated but becoming cylindrical with age. This feature is unlikely to be homologous with the inflated rhizoidal cells in the mature thalli of some species in the section *Batrachospermum* (Vis *et al.* 1995) and does not appear to have any taxonomic utility in *B. atrum* (i.e. it does not correlate with any other features and there is some variability within and between individuals).

Spermatangial Distribution: Spermatangia were commonly borne on involucral bracts (Fig. 3C) in specimens referable to all three groups delineated by Entwisle (1992). In contrast to the North American specimens studied by Sheath *et al.* (1993a), spermatangia were not restricted to involucral filaments (diagnostic of *B. androinvolucrum*) or only vegetative fascicles (*B. atrum*): see Fig. 3C and D. This less discriminating distribution of spermatangia is similar to that reported for species such as *B. confusum* and *B. spermatoinvolucrum* (section *Batrachospermum*), and *B. globosporum* (section *Contorta*) (Sheath *et al.* 1993a, Vis *et al.* 1995, Vis and Sheath 1996). In the absence of collaborating characters, and because this feature seems to cross all intuitive taxonomic boundaries (i.e. the three groups of Entwisle 1992), the Australian populations are retained within *B. atrum*.

Some collections from Tasmania (*Entwisle 2516, 2520, 2625*) had very distinctive 'clipped poodle'-like whorls as have been noted before in some Group B (*sensu* Entwisle 1992) specimens of *B. atrum*. Such specimens produced an abundance of spermatangia on primary and secondary fascicles. However, profuse spermatangia can occur in collections with other whorl morphologies (e.g. *Entwisle 2397*).

Carpogonium Size: One collection from Western Australia (*Entwisle 2403*) had very small carpogonia (not more than 14 µm long). However, the material was overmature and carpogonia were difficult to locate and score. Until further material is collected this aberration is assumed to be yet further variation in *B. atrum*.

Carposporophyte Size: The carposporophytes scored were sometimes up to 250 µm in diameter (and larger when apparently two or more became intertwined; *Entwisle 1921*). This size range, from 100–230 µm in diameter (i.e. broadest dimension of semi-globose mass) is similar to that reported for *B. atrum* by Sheath *et al.* (1993a): although *B. atrum* has often larger carposporophytes than *B. androinvolucrum* Sheath *et al.*, the range of the former includes entirely that of the latter.

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[1] From 36 localities additional to those reported in Entwisle (1992). Collection details of specimens referred to in text but not documented here can be found in Entwisle (1992).

Indeterminate Gonimoblast Filaments: In a number of specimens examined (e.g. *Entwisle 39, 2233, 2381, 2553, 2445*), some gonimoblast filaments extended along the axis beyond the main carposporophyte mass (Fig. 3E, F). These filaments appear to be technically indeterminate (producing short carposporangial filaments laterally and never terminated by a carposporangia) but of limited growth. They appear to be homologous with the gonimoblast filaments observed in *B. terawhiticum* but of more limited growth. Similar filaments are produced in some populations of *B. turfosum*: homology of these states is tested in the cladistic analysis.

Carposporophyte Position in Whorl: In specimens from Dargans Creek (New South Wales; *Entwisle 1921, Entwisle 1925*) the gonimoblast begins as sessile on the axis but becomes stalked and centred away from the axis in older thalli. Again, there does not seem to be any taxonomic utility in this feature.

Lake Mountain variant: A specimen from Lake Mountain National Park (Victoria; *Entwisle* 2445) had inflated rhizoidal filament cells up to 21 µm in diameter (Fig. 4C; but cf. Fig. 4A), rhizoidal filaments spiralled (rope-like) around the axial filament in some mature parts (Fig. 4B). Secondary fascicles were absent in some parts (where rhizoidal filaments were inflated and spiralling) and common in other parts, sometimes bearing carpogonial branches. Carpogonia varied considerably in size yielding measurements outside previous ranges for *B. atrum:* 25–54(–60) um long and trichogyne 4–11 µm in diameter at broadest part. The involucral bracts were terminated by elongate cells (to 15 µm; 4D), which may have been spermatia (although spermatia of a size and shape typical of *B. atrum* were observed on fascicles). This population warrants further study, but none of these features in isolation or in combination warrant the establishment of a new taxon at this stage.

Cladistic Analysis

Characters

All characters used to define taxa in the Batrachospermales were assessed for the cladistic analysis. Some were autapomorphies and were excluded as uninformative. Others were too poorly documented or inconsistently applied: e.g. trichogyne shape was too variable within taxa as well as being difficult to circumscribe as a character.

The following characters are used in the analysis.

0. *Thallus* multiaxial (0) or uniaxial (1). Only *Thorea* is multiaxial but autapomorphies in outgroups are informative.
1. *Thallus apical cell diameter*: c. 4–8 µm (0), 10–15 µm (1). The broad apical cells of *B. diatyches* and *B. latericium* tend to be hemispherical as well as relatively broad, but further documentation in other taxa is required before shape can be used as a phylogenetic character. The degree to which the apical cell protrudes from the whorls of fascicles also warrants further study. The scoring of apical cell diameter in *Lemanea fluviatilis* is based on equivocal observations from dried herbarium material of this species at MEL, as well as generalisations on the family from the illustrations of Atkinson (1890) and Bourrelly (1985) and personal observations by M. Vis-Chiasson on *Paralemanea*. However, Sheath (1984) includes photographs of *L. fucina* with apical cells 4–8 µm, and the scoring of this character in *L. fluviatilis* should be verified (particularly given its reversal in the two shortest trees).
2. *Fascicle adherence*: partly or not at all (0), complete (1). *Tuomeya* and *Lemanea* have completely adhering outer cortical layers, unlike any other taxa considered here.

3. *Rhizoidal filament cell shape:* elongate (0), brick-like (1). See taxonomic section above for definition of brick-like rhizoidal filament cells. Rhizoidal filaments are absent in *Lemanea fluviatilis* and not applicable in *Thorea*.
4. *Fascicle cell storeys*: 5 or more (0), 1–6 (1). To be scored as 0, at least some fascicles on each individual must have 7 or more cell storeys. The ‘fascicles’ of *Lemanea fluviatilis*, if traced from the axis to the outer cortex, are more than 5 cells long.
5. *Fascicle cell shape:* audouinelloid (0), not audouinelloid (1). See Necchi (1990b) for definition of audouinelloid filaments.
6. *Monosporangia* present (0) or absent (1). The presence of monosporangia in *Thorea* requires confirmation (Necchi and Zucchi 1997) and *T. violacea* has been split into two entities, one with monosporangia, the other without.
7. *Spermatangia on involucral filaments* (1) or not (0). Although the presence of spermatangia on involucral filaments distinguishes *B. androinvolucrum* from *B. atrum*, as mentioned earlier some populations of *B. atrum* from Australia have spermatangia on involucral filaments as well as elsewhere in whorls. *Batrachospermum atrum* is divided into four taxa to represent variation in this character and character 16. The absence of spermatangia on vegetative filaments is an autapomorphy for *B. androinvolucrum* and is not included in this analysis.
8. *Carpogonial branches* arising mostly from intercalary fascicle cells (0) or exclusively from periaxial cells or proximal cell of fascicles (1). The differentiation of carpogonial branches is variable within the group studied, and is difficult to categorize (see e.g. Entwisle and Foard 1997). However the origin of what is generally accepted as ‘the carpogonial branch’ seems to fall into the two categories defined here (sometimes it is difficult to distinguish between an origin from the periaxial cell and the proximal fascicle cell, so a strict scoring of periaxial cell only seemed too impractical).
9. *Carpogonial branches* straight (0) or curved to spiralled (1). *Lemanea* generally seems to have somewhat curved carpogonial branches (see Atkinson 1890) but carpogonial branches in this genus are difficult to observe and seldom described.
10. *Carpogonial branch length*: never more than 5 cells long (0), usually 5 or more cells (1). The unbranched filament subtending the carpogonium is considered to be the carpogonial branch in all taxa.
11. *Carpogonial base* more or less symmetrical (0) or strongly asymmetrical (1). The carpogonial bases in *Sirodotia* and *Tuomeya* are clearly symmetrical in relation to the trichogyne pedicel. All other taxa have a symmetrical or slightly oblique carpogonial base in relation to the trichogyne pedicel.
12. *Trichogyne longevity*: not persisting after fertilisation (0), persisting after fertilisation (0).
13. *Trichogyne shape*: linear (0) or swollen (1). More precise characterisation of trichogyne shape was not possible due to variation reported within currently circumscribed species.
14. *Trichogyne attachment*: sessile (0) or pedicellate (1). See Sheath *et al.* (1986) for definition of ‘pedicellate’ vs ‘sessile’. The trichogynes of *Sirodotia suecica* and *Tuomeya americana* are somewhat intermediate in terms of pedicel definition but they have been scored here as pedicellate. When the trichogyne is linear (character 13 = 0), this character is inapplicable.
15. *Carposporophyte* with determinate filaments bearing carposporangia clustered around the carpogonium (1) or not (0). If no carposporophytes are produced (as in *B. turfosum* 1), this character is inapplicable.
16. *Indeterminate gonimoblast filaments*: present (0) or absent (1). Inapplicability as for character 15. The carposporophytes of *Thorea* (Necchi pers. comm.), *Sirodotia* and *Nothocladus* consist of long indeterminate filaments giving rise

laterally to branched determinate filaments bearing clusters of carposporangia. 'Shortly indeterminate' filaments, extending a relatively short distance from a mass of determinate gonimoblast filaments, are found in some species of *Batrachospermum*. There is some debate about the validity of this feature (e.g. Sheath *et al.* 1994a) but it has been confirmed in at least some populations of *B. atrum* (this study) and *B. turfosum* (Kumano *et al.* 1970, as *B. vagum*). For this reason these two taxa have been divided to account for this variation (see also note under character 7 regarding *B. atrum*). The inclusion of 'short' and 'long' indeterminate gonimoblast filaments as a separate character state resulted in an unacceptably large number of trees due to the predominance of the inapplicable character state in the matrix (i.e. for all taxa lacking indeterminate gonimoblast filaments). This character requires further study.

17. *Carposporophytes per whorl*: 1 or 2 per whorl (0), usually more than 2 (1). If the thallus is multiaxial (character 0 = 0) or carposporophytes are not produced (as in *B. turfosum* 1), this character is inapplicable.
18. *Carposporophytes 'centred'*: variously in whorl (0), on axis (1), on outside cortical layer (2). See Entwisle & Foard (1997) for definition of centred. If determinate gonimoblast filaments are absent (character 15 = 0) or carposporophytes are not produced (as in *B. turfosum* 1), this character is inapplicable. Treated as non-additive in analysis.
19. *Carposporophytes in whorl*: fully embedded (0), protruding (1). Inapplicability as for character 18.

Taxa

The data matrix (Appendix 1) included all taxa currently included in the section *Setacea/B. atrum* complex, as well as species chosen to represent the major clades of the consensus tree based on combined 18S and rbcL data in Vis *et al.* (1998). *Psilosiphon scoparium* has no know sexual reproduction and has been excluded from the study (all but 4 characters would be scored 'not applicable'). *Thorea* was chosen as the outgroup based on the results of Vis *et al.* (1998). When *Rhododraparnaldia* was included in our matrix it was placed as sister to *B. diatchyes* in all shortest trees. However as we were unable to include *Audouinella arcuata* and *Palmaria palmata* (part of the clade including *Rhododraparnaldia* in the molecular trees) due to lack of sufficient comparable data, this relationship was probably an artefact of overall similarity.

Results and Discussion

70 shortest trees of branch length 56 with a CI of 37 and an RI of 41 were found. The Nelson consensus tree is shown in Fig. 5. In all shortest trees the section *Setacea* (*B. androinvolucrum*, *B. atrum*, *B. diatyches*, *B. latericium* and *B. puiggarianum*) is monophyletic, and the two Tasmanian endemics *B. diatyches* and *B. latericium* are sister taxa. The proposal by Necchi and Entwisle (1992) to include the setaceous species in section *Virescentia* (represented here by *B. helminthosum*) is not supported. Instead there is weak support for a close relationship between the sections *Turfosa* and *Setacea*.

The consensus tree is poorly resolved overall and shows little congruence with that produced from the combined molecular data set by Vis *et al.* (1998, fig. 3). For example, the relationship between *Sirodotia* and *Lemanea* is unresolved in our consensus tree, but strongly bootstrap-supported as a monophyletic clade with the combined molecular data. Unfortunately, the paraphyly of *Batrachospermum s. str.* and Batrachospermaceae as clearly demonstrated in Vis *et al.* (in press) is neither

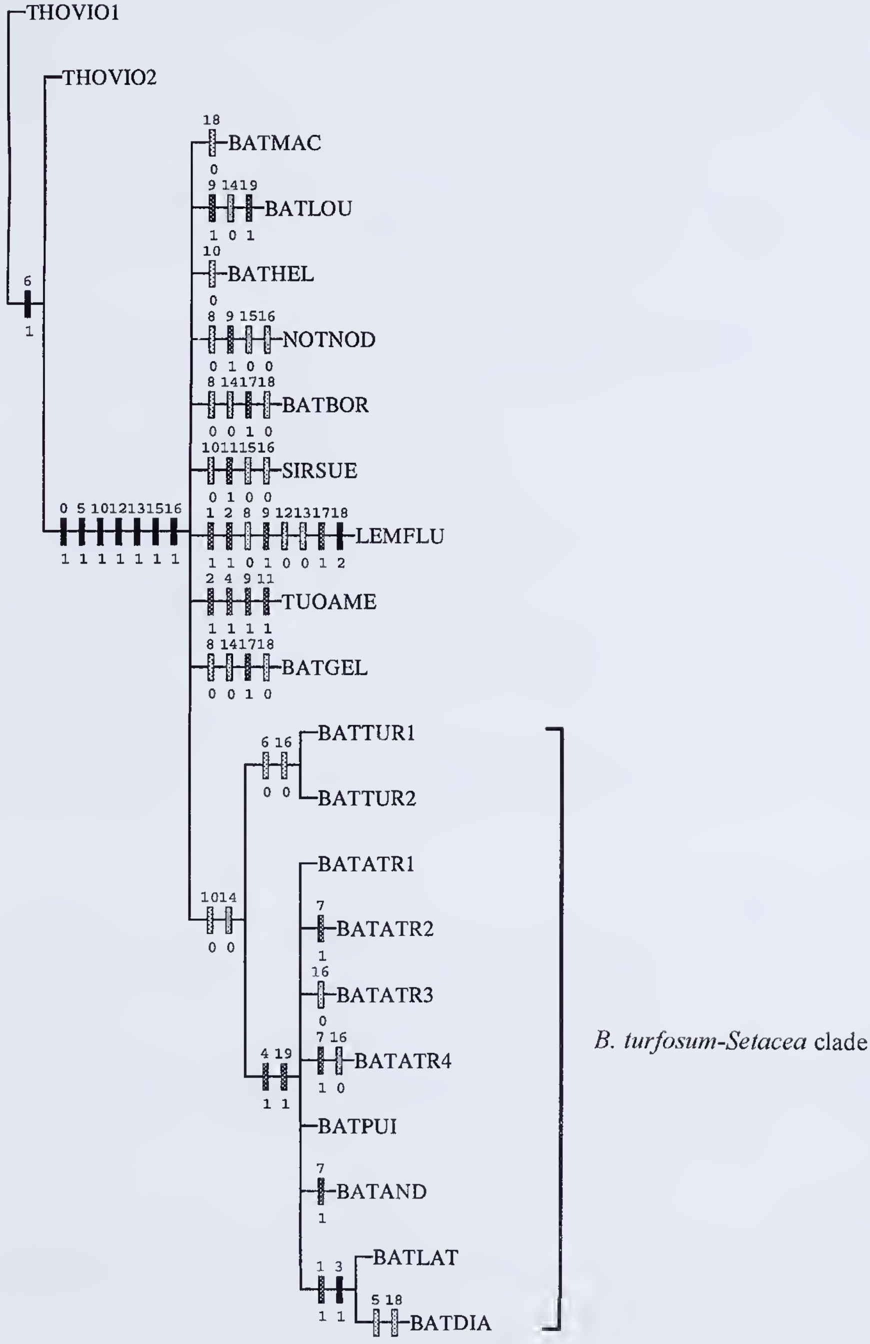

Fig. 5. Strict consensus tree from the 70 shortest trees using Nona (with multi* option) on data in appendix 1 with '*Thorea violacea* 1' as outgroup. L = 56, CI = 37, RI = 41. The taxa are designated by the first three letters of the genus followed by the first three letters of the species.

supported nor opposed in our tree. While the tree presented here supports the recognition of the section *Setacea*, further resolution of Batrachospermales must await the addition of more taxa and characters.

In all shortest trees the brick-like rhizoidal filament cells (character 3 = 1) and large thallus apical cells (character 1 = 1) are derived character states within the Batrachospermales *s. str.* There is a single parallelism of the apical cell size character in *Lemanea fluviatilis*, but as noted under 'Characters' the scoring of character 1 in this taxon needs verification. The brick-like rhizoidal filament cells are a synapomorphy uniting *Batrachospermum latericium* and *B. diatyches*.

Indeterminate gonimoblast filaments (character 16 = 0) are homoplaseous in the consensus tree. As explained above, 'short' and 'long' indeterminate gonimoblast filaments could not be used as character states in this analysis. However, if shortly indeterminate gonimoblast filaments are plotted on the consensus tree, they occur only in the *B. turfosum-Setacea* clade. Further study should focus on the development and distribution of shortly determinate gonimoblast filaments, and the homology of long indeterminate gonimoblast filaments in *Thorea*, *Sirodotia* and *Nothocladus* (there is a reversal in this character between the *Thorea* and the latter taxa).

The use of distribution of spermatangia as a taxonomic character in section *Batrachospermum* has been analysed recently by Vis and Sheath (in press). Based on molecular and morphological data, Vis and Sheath (in press) reduce *B. spermatoinvolucrum*, characterised by the presence of spermatangia on involucral filaments as well as on vegetative fascicles, to a form of *B. gelatinosum*. In 'section *Setacea*', *B. androinvolucrum* produces spermatangia exclusively on involucral filaments, while at least some populations of *B. atrum* have spermatangia on both involucral filaments and vegetative fascicles. In Fig. 5, the presence of spermatangia on involucral filaments (character 7 = 1) is a derived character but the tree is unresolved in relation to *B. androinvolucrum* and *B. atrum*. The circumscription of *B. atrum* is still unconvincing, and further characters are needed to define robust taxa in all but the *B. diatyches-B. latericium* group of the section *Setacea*.

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Appendix 1. Data matrix for phylogenetic analysis.

- = Not applicable
* = outgroups (as defined in Vis *et al.* 1998, fig. 3)

	0	5	10	15
*Thorea violacea 1	0 0 0 - 0	0 0 0 - 0	0 0 0 0 -	0 0 - - -
*Thorea violacea 2	0 0 0 - 0	0 1 0 - 0	0 0 0 0 -	0 0 - - -
Batrachospermum macrosporum	1 0 0 0 0	1 1 0 1 0	1 0 1 1 1	1 1 0 0 0
Batrachospermum louisianae	1 0 0 0 0	1 1 0 1 1	1 0 1 1 0	1 1 0 1 1
Batrachospermum helminthosum	1 0 0 0 0	1 1 0 1 0	0 0 1 1 1	1 1 0 1 0
Batrachospermum turfosum 1	1 0 0 0 0	1 0 0 1 0	0 0 1 1 0	- - - - -
Batrachospermum turfosum 2	1 0 0 0 0	1 0 0 1 0	0 0 1 1 0	1 0 0 1 0
Nothocladus nodosus	1 0 0 0 0	1 1 0 0 1	1 0 1 1 1	0 0 0 - -
Batrachospermum boryanum	1 0 0 0 0	1 1 0 0 0	1 0 1 1 0	1 1 1 0 0
Sirodotia suecica	1 0 0 0 0	1 1 0 1 0	0 1 1 1 1	0 0 0 - -
Lemanea fluviatilis	1 1 1 - 0	1 1 0 0 1	1 0 0 0 -	1 1 1 2 0
Tuomeya americana	1 0 1 0 1	1 1 0 1 1	1 1 1 1 1	1 1 0 1 0
Batrachospermum gelatinosum	1 0 0 0 0	1 1 0 0 0	1 0 1 1 0	1 1 1 0 0
Batrachospermum atrum 1	1 0 0 0 1	1 1 0 1 0	0 0 1 1 0	1 1 0 1 1
Batrachospermum atrum 2	1 0 0 0 1	1 1 1 1 0	0 0 1 1 0	1 1 0 1 1
Batrachospermum atrum 3	1 0 0 0 1	1 1 0 1 0	0 0 1 1 0	1 0 0 1 1
Batrachospermum atrum 4	1 0 0 0 1	1 1 1 1 0	0 0 1 1 0	1 0 0 1 1
Batrachospermum puiggarianum	1 0 0 0 1	1 1 0 1 0	0 0 1 1 0	1 1 0 1 1
Batrachospermum androinvolucrum	1 0 0 0 1	1 1 1 1 0	0 0 1 1 0	1 1 0 1 1
Batrachospermum latericium	1 1 0 1 1	1 1 0 1 0	0 0 1 1 0	1 1 0 1 1
Batrachospermum diatyches	1 1 0 1 1	0 1 0 1 0	0 0 1 1 0	1 1 0 0 1

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A New Species of *Eucalyptus* (series *Subexsertae*) from the Northern Territory.

N.G. Walsh[1] *and D.E. Albrecht*[2]

1. National Herbarium of Victoria, Birdwood Ave, South Yarra, Victoria 3141, Australia
2. Alice Springs Herbarium, Parks and Wildlife Commission of the Northern Territory, PO Box 1046, Alice Springs, Northern Territory 0871, Australia.

Abstract

Eucalyptus gregoriensis, a new species in series *Subexsertae* Blakely, informal section *Exsertaria* of Pryor and Johnson (1971) from the Victoria River district of the Northern Territory is described and illustrated, its distribution and conservation status provided, and its affinities to other members of the *Subexsertae* in the region are discussed. Its nearest relative appears to be *E. cupularis* C.A. Gardner from which it differs most significantly in its 3-flowered, subsessile umbellasters.

Introduction

In April 1996, a collecting expedition to the Gregory National Park, a reserve of some 13000 km^2, situated about 400 km SSW of Darwin, was undertaken with botanists from the National Herbarium of Victoria, the herbaria of the Northern Territory in Darwin and Alice Springs, and biologists and rangers from the Parks and Wildlife Commission of the Northern Territory. The expedition was in commemoration of the sesquicentenary of the founding of the Royal Botanic Gardens Melbourne, and the centenary of the death of Ferdinand Mueller, the first Government Botanist of the colony of Victoria. The expedition was to revisit some of the ground covered by the North Australian Expedition of 1855–56, led by A.C. Gregory and on which Mueller travelled as botanist (see Cumpston 1972), and to compile an inventory of plants and animals for the western and southern sections of the National Park. In the course of the expedition, several undescribed plants were discovered (and one rediscovered after nearly 150 years; see also Bean, Craven, this volume).

Taxonomy

Eucalyptus gregoriensis N.G. Walsh & D.E. Albrecht, sp. nov.

Eucalypto cupulari C.A. Gardner et *E. herbertianae* affinis inflorescentiis floribis tribus, subsessilibus differt.

Type: Northern Territory, Victoria River District, Gregory National Park, tributary of East Baines River, 50 km SW from Bullita outstation, *N.G. Walsh 4547 and G.J. Jones,* 17.iv.1996 (holotype MEL; isotype DNA).

Small *tree* or mallee, usually of crooked or semi-weeping habit, to 8 m high. *Canopy* rather open with more or less weeping foliage. *Bark* smooth and white throughout, powdery. *Pith glands* absent. *Cotyledons* broadly cordate or shallowly bilobed, c. 3–4 mm long, 4–5 mm wide, reddish below. *Seedling leaves* shortly petiolate, elliptic, to c. 3 cm long, 15 mm wide, opposite for c. 10 nodes. *Juvenile leaves* alternate, ovate, to 18 cm long, 9 cm wide, slightly discolorous, dull grey-green, lightly waxy; venation reticulate, intramarginal vein 1.5–5 mm from margin;

oil glands numerous, island. *Adult leaves* alternate, narrowly lanceolate, sub-falcate, mostly 11–22 cm long, 12–30(–38) mm wide, concolorous, dull grey-green, drying yellow-green, thick-textured; venation densely reticulate, intramarginal vein 0.6–2.5 mm from margin; oil glands rather sparse, mostly intersectional, obscure; petioles flattened, (1.5–)2–3(–4) cm long. *Umbellasters* 3-flowered, axillary, or occasionally without subtending leaves or bracts; peduncles 0.5–2(–4) mm long, thick, terete or weakly 2-angled. *Buds* (when near mature) sessile, obovoid, 6–10 mm long, 3–4 mm wide, weakly to strongly 2-angled, non-waxy; operculum narrow-hemispherical, slightly shorter to (rarely) slightly longer than hypanthium, obtuse to broadly acute, outer operculum shedding early. *Stamen* filaments variously flexed in near-mature buds; anthers all fertile, versatile, thecae oblong, dehiscing longitudinally. *Ovary* 4(5)-locular; ovules in 4 rows per locule. *Fruits* sessile, hemispherical to cupular, 5–7.5 mm long, and as wide or slightly wider, usually 2-angled (slightly ribbed), at least near base; disc flat to slightly ascending or domed; valves 4 (very rarely 5), strongly exserted, triangular, 2.5–3.5 mm long, acute. *Seeds* black or very dark red-brown, 1.5–2 mm long, angular, with an irregularly dentate or denticulate flange along the angles; hilum terminal. (Fig. 1)

Specimens Examined

Northern Territory: Gregory National Park, c. 45 km SSW of Bullita outstation, *M.F. Duretto 1185 and T.A. Davies*, 17.iv.1996 (CANB, DNA, MEL); Gregory National Park, Wickham River, c. 2 km upstream of junction with Broadarrow Creek, *M.J. Barritt 2281 and D.E. Albrecht*, 16.iv.1996 (DNA): Gregory National Park, headwater of tributary of Snake Creek, 30 km WSW Bullita outstation, *N.G. Walsh 4437 and C.A. Coles*, 16.iv.1996 (DNA, MEL); cultivated seedling from Walsh 4437, *C.R. Dunlop 10185* (DNA); Victoria River Downs, Gordon Ck Gorge, *P.K. Latz 10298*, 31.v.1986 (DNA).

Distribution and Conservation Status

Eucalyptus gregoriensis is known by collections from four localities in the western sector of the Gregory National Park, Northern Territory and one from the adjacent Victoria River Downs Station. Given that the area of occurrence is difficult to access and there has been limited, site-specific fieldwork, it is likely to be found in more locations within Gregory National Park (and possibly adjoining lands). Conservation status is assessed at 2RC- (Briggs and Leigh 1996).

Habitat

All collections of the new species have been made from shallow soils overlying sandstones, immediately adjacent to seasonal watercourses, or on cliffs and subtending slopes fringing watercourses. Grows in woodland dominated by *Corymbia* spp. (e.g. *C. cliftoniana*, *C. aspera*), *Eucalyptus brevifolia*, *Xanthostemon paradoxus*, *Gardenia* spp. etc.

Etymology

The epithet refers to the Gregory National Park, from where all but one collections of the species have been made to date. It also commemorates A.C. Gregory, leader of the successful North Australian Expedition (1855–56) in which the first European exploration of the area was undertaken.

Notes

Eucalyptus gregoriensis is placed in the series *Subexsertae* (Chippendale, 1988) excluding those species transferred to the series *Brevifoliae* by Brooker and Slee

(1994). The uniformly coloured bark, absence of pith glands, subequal operculum and hypanthium, fruit with strongly exserted valves, and angular dark seeds with an irregularly dentate or denticulate flange along the angles are characteristic features of the series *Subexsertae*. The broadly cordate or shallowly bilobed cotyledons of *E. gregoriensis* however appear to be anomolous within the series (*Subexsertae* members typically have reniform cotyledons). In a geographical sense, *E. gregoriensis* also fits well within the series which is almost exclusively distributed in tropical northern Australia.

In the classification system proposed by Pryor and Johnson (1971) *E. gregoriensis* would be placed in the section *Exsertaria*, series *Albae*, subseries *Herbertianae* (with *E. cupularis* and *E. herbertiana* the other members of the subseries).

Eucalyptus gregoriensis closely resembles *E. cupularis* C.A. Gardner, and to a lesser degree, *E. herbertiana* Maiden. The three taxa are similar with respect to the shape of the buds, fruit and seeds, strongly exserted valves and alternate adult leaves. The new species differs from both *E. cupularis* and *E. herbertiana* in its shorter peduncle (0.5–2(–4) mm long for *E. gregoriensis*; $\geq$ 4 mm long for the other species) and in its consistently 3-flowered inflorescences. It also tends to have larger fruit than *E. herbertiana* (which has fruits usually $\leq$ 5 mm long) that appear to be consistently sessile (pedicellate to sessile in *E. herbertiana*). Three-flowered inflorescences are atypical in the informal section Exsertaria and otherwise are typically found only in *E. morrisii* R. Baker and (less commonly) in *E. nandewarica* L.A.S. Johnson and K.D. Hill, both mallees or small trees of inland northern New South Wales, and both belonging to series *Exsertae* Blakely.

Acknowledgements

We are grateful to colleagues who participated in the 1996 collecting trip to Gregory National Park, particularly to Clyde Dunlop (DNA) who first drew our attention to the distinctiveness of the new species and who made some valuable comments on a draft of this paper. The 1996 Gregory trip was sponsored by the Parks and Wildlife Commission of the Northern Territory, Friends of the Botanic Gardens, Melbourne Inc., Qantas, Hoechst Australia Ltd, and the Australian Geographic Society, and we are indebted to these organisations. We also thank Thomas Brosch (MEL) who drew the accompanying figure.

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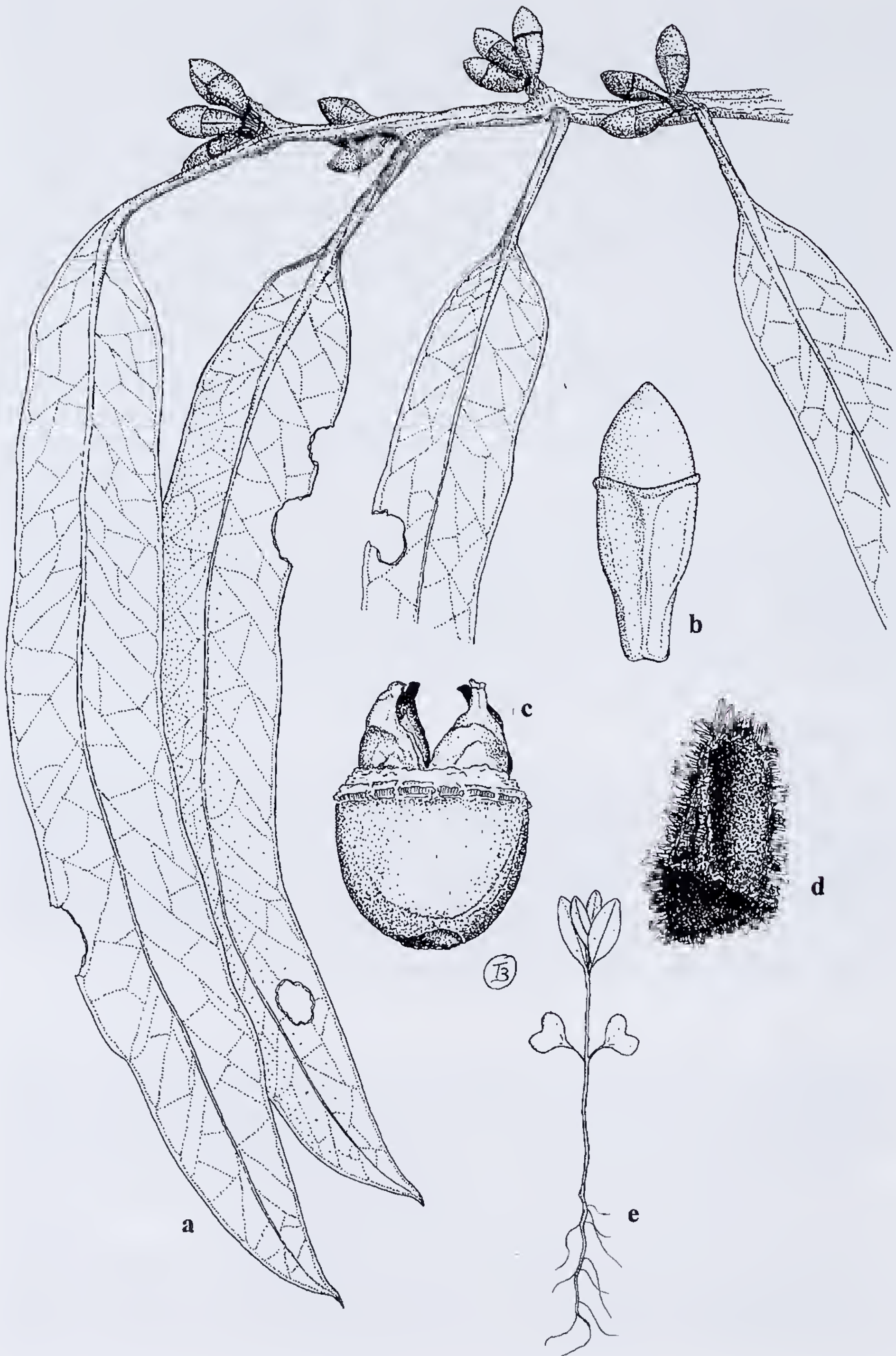

Fig. 1. *Eucalyptus gregoriense*; **a** branchlet in bud x 1; **b** near-mature bud x 4; **c** mature capsule x4; **d** seed x 20; **e** seedling x1 (all from *Walsh 4547*, MEL).

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Observations on the Lichen Genus *Lempholemma* Körb. in Australia

Gintaras Kantvilas[1] and Per Magnus Jørgensen[2]

[1]Tasmanian Herbarium , GPO Box 252C, Hobart, Tasmania, Australia 7001
[2]Botanical Institute, University of Bergen, Allégaten 41, N-5007, Bergen, Norway

Abstract

The genus *Lempholemma* in Australia comprises the single species, *Lempholemma polyanthes* (Bernh.) Malme [synonym: *L. myriococcum* (Ach.) Th. Fr.]. This species is recorded from Tasmania and Victoria, and its morphology, anatomy, distribution and ecology are discussed. A lectotype for *L. polyanthes* is designated. *L. hypolasium* (Stirt.) F.M. Bailey is a synonym of *Physma byrsaeum* (Pers.) Mont. *Synalissa cancellata* F. Wilson, a further synonym of *Lempholemma polyanthes*, is neotypified. The genus *Synalissa* does not appear to occur in Australia.

Introduction

Lempholemma Körb. is a poorly known, heterogeneous genus of blackish, gelatinous species belonging to the family Lichinaceae, characterised by simple ascospores and a homoiomerous thallus with a photobiont belonging to the genus *Nostoc*. About 30 species have been described (Hawksworth *et al.* 1995), mainly from the Northern Hemisphere where they occur mostly on calcareous rocks. Aspects of the genus have been discussed by Henssen (1968) and Schiman-Czeika (1988). *Lempholemma* has never been properly recognised in the Australian flora, although Filson (1996) records three species: *L. hypolasium* (Stirt.) F.M. Bailey, *L. myriococcum* (Ach.) Th. Fr. and *L. polyanthes* (Bernh.) Malme.

Lempholemma hypolasium was first described as a *Collema* (Bailey 1899), based on a collection from the Gowrie Mountains near Brisbane, Queensland, by F.M. Bailey in 1877. Studies of the isotype in BM have shown this taxon to be a synonym of *Physma byrsaeum* (Pers.) Mont. The first Australian record of *L. myriococcum* was by Wilson (1891) who referred one of his collections from Mt Macedon, Victoria to "*Synalissa micrococca* Born. & Nyl.". Subsequently, Wilson (1892) described his specimen as *Synalissa cancellata* F. Wilson, and later also recorded the species from the South Esk River, Launceston, Tasmania (Wilson 1893). On the basis of a specimen obtained from Wilson, Shirley (1894) correctly identified this taxon as conspecific with *Lempholemma myriococcum*, a fact which has been generally overlooked by Australian lichenologists, despite this information being reiterated by Zahlbruckner (1925). Thus the name *Synalissa cancellata* has continued to be cited in checklists for Australia, for example Filson (1996) and its forerunners, and for Tasmania (Kantvilas 1994). In fact, the genus *Synalissa* is not known to occur in Australia at all, although a superficially similar lichen from an undescribed genus has been collected from south-western Tasmania (Henssen, Jørgensen & Kantvilas, in prep.). Material in Australian herbaria referred to *Synalissa*, including that of *S. symphorea* (Ach.) Nyl. which is recorded by Filson (1996) for the Australian mainland, has been reidentified to other genera, mainly *Peccania*, by Professor Dr A. Henssen.

In this paper, we provide an account of *L. polyanthes*, the only species of the genus known currently from Australia. This species is widespread in the temperate Northern Hemisphere where it occurs amongst bryophytes, chiefly over calcareous rocks (Santesson 1993, Purvis *et al.* 1992). Its morphology, anatomy, distribution and ecology in Australia (including Tasmania) are discussed here.

Lempholemma polyanthes (Bernh.) Malme, *Lich. suec. exs.* 883 (1924). *Lichen polyanthes* Bernh. in Schrader, *Syst. Samml. krypt. Gew.*: 82 (1797). *Type:* Germania, ex herb. Schrader (lectotype, here designated, L!).

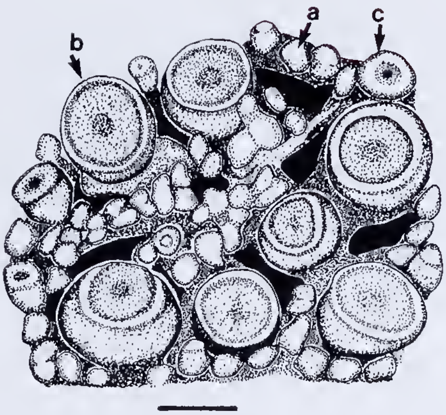
Lempholemma myriococcum (Ach.) Th. Fr., *Nova Acta R. Soc. Scient. upsal.*, ser. 3, 3: 381 (1861); *Lichen myriococcus* Ach., *Lichenogr. Suec. Prodr.*: 127 (1799). *Type:* Suecia (H-ACH!).

Synalissa cancellata F. Wilson, *Proc. Roy. Soc. Vic.* 5: 151 (1892). *Type:* Australia [Victoria:], Mt Macedon, on subalpine rocks and moss (neotype, here designated, BRI *492018*!).

Thallus homoiomerous, forming a membranous or strand-like film over bryophytes, with numerous irregular fissures, fenestrations and ridges, usually densely covered with discrete or coalescing, warty granules or ± erect, unevenly cylindrical lobules to c. 0.2 mm wide, blackish olivaceous when dry, dark olivaceous and swelling to a granular, pulpy cushion to c. 5 cm wide when wet. *Hormocystangia* absent. *Photobiont Nostoc*, forming chains of cells 4–6 µm diameter, loosely interwoven in a gelatinous matrix with sparsely branched hyphae c. 1.5 µm thick. *Apothecia* ± immersed at first in the swollen apices of granules and lobules, sometimes appearing rather perithecia-like when young, with a sunken, pore-like brownish disc, 0.1–0.2 mm wide, becoming ± globular when well developed; disc soon exposed, ± glossy brown to orange-brown, plane to concave, 0.2–0.3 (–0.4) mm wide; thalline margin thin, persistent or becoming excluded in oldest apothecia. *Hymenium* colourless, 150–270 µm thick, I+ reddish before pretreatment in KOH, I+ blue after pretreatment, surrounded by a cupular excipulum of plectenchymatous to paraplectenchymatous hyphae, c. 30–40 µm thick. *Asci* thin-walled, cylindrical, entirely non-amyloid, 70–100 × 14–20 µm, eight-spored. *Ascospores* hyaline, uniseriate, ellipsoid, thin-walled, (12–) 15–20 × 7–10 µm. *Paraphyses* simple, straight, 1.5 µm thick, with tapered or rounded apices. *Pycnidia* immersed in swollen granules and lobules; ostioles very obscure, lateral and apical. *Conidia* ellipsoid, 1.8–2.5 × 1–1.2 µm. (Figs 1–3)

Notes

Because of its small and inconspicuous nature, *Lempholemma polyanthes* is very easily overlooked in the field and hence its distribution (Fig. 4) should be regarded as very incomplete. It has been recorded from lowland to alpine altitudes, and from a wide range of vegetation types including grassland, heathland, sedgeland, sclerophyll forest and cool temperate rainforest. It grows exclusively over bryophytes, especially mosses, on wet, or at least intermittently moist rocks and soil, such as in stream beds, seepage cracks or on the shaded aspects of bluffs and boulders. Rock types from which *L. polyanthes* has been recorded include dolerite, sandstone, limestone and serpentine. The species associates with a very wide range of bryophytes, depending on its habitat. At alpine and subalpine altitudes, these are typically species of *Grimmia* and *Andraea.* At lower altitudes, especially in sclerophyllous vegetation types, some of the mosses from which it has been recorded include *Barbula pseudopilifera, Breutelia affinis, Hypnum*



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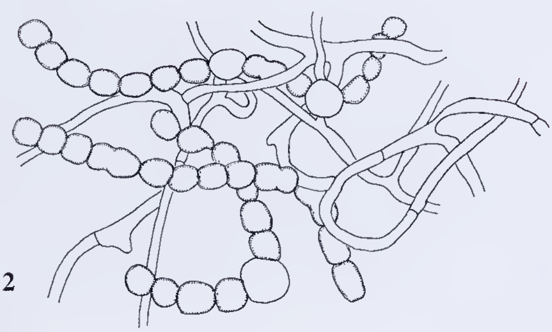

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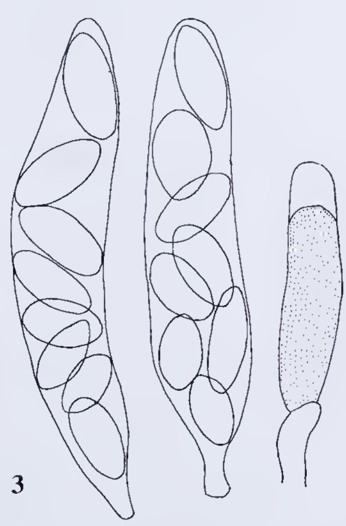

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Fig. 1. Habit of *Lempholemma polyanthes* : **a** granules, **b** mature, and **c** immature apothecia. Scale = 250 µm.

Fig. 2. Anatomy of *Lempholemma polyanthes* : chains of *Nostoc*, loosely interwoven with fungal hyphae. Scale = 7.5 µm.

Fig. 3. Asci and ascospores of *Lempholemma polyanthes;* immature ascus RHS. Scale = 15 µm.

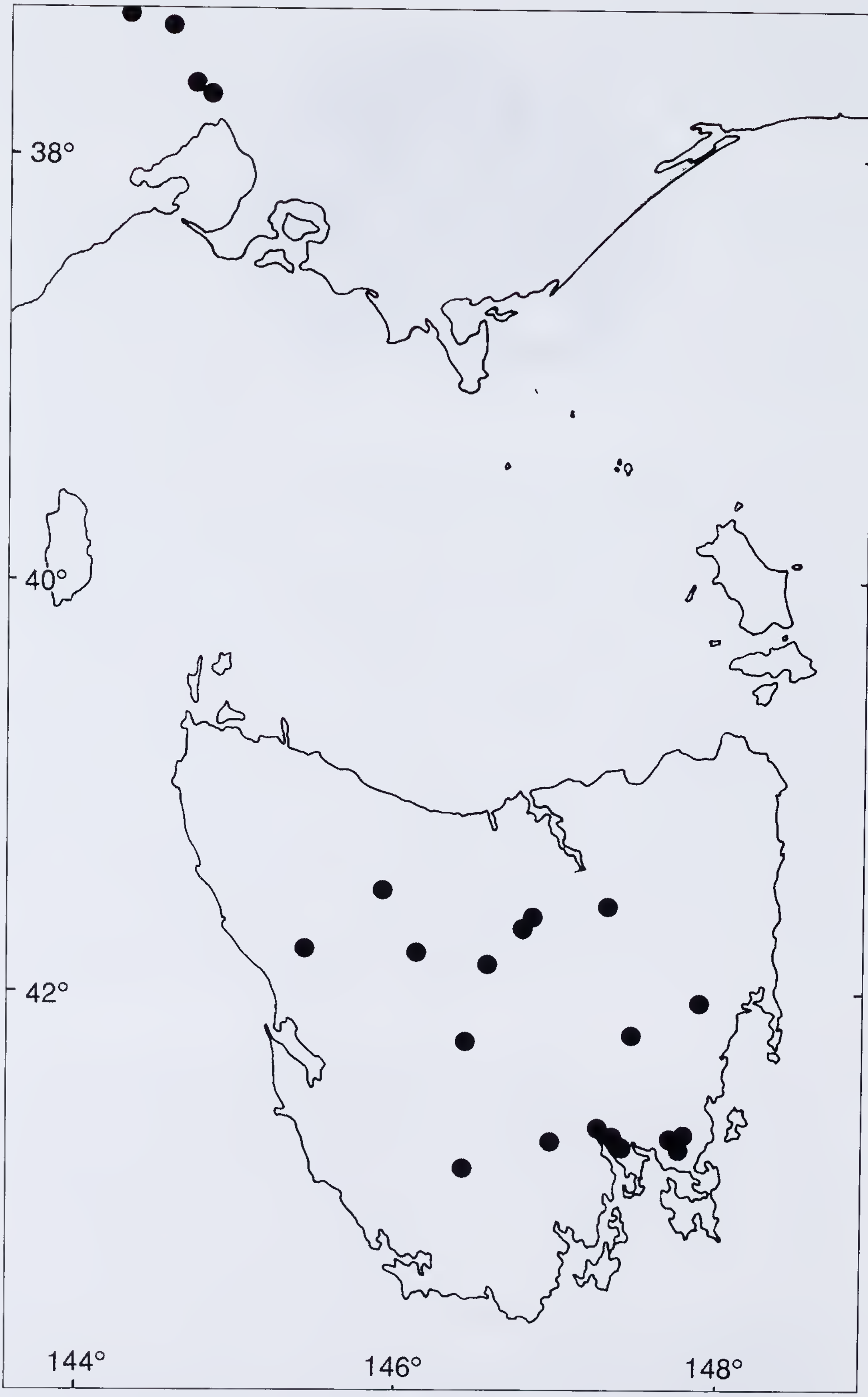

Fig. 4. Distribution of *Lempholemma polyanthes* in Australia.

cupressiforme, Racomitrium crispulum, Thuidium sparsum, Triquetrella papillata and species of *Grimmia*. In rainforest, it was recorded from tufts of *Zygodon intermedius* mixed with unidentifed leafy hepatics.

Lempholemma polyanthes appears to be widespread in Tasmania, mainly in the central, northern and eastern Jurassic dolerite-dominated provenance. Significantly, it has not been recorded from the south-west of Tasmania, despite intensive, albeit localised, study in that region. There at least part of its typical ecological niche is occupied by a superficially similar although unrelated taxon (containing *Gloeocapsa* as the photobiont), which represents an undescribed genus (A. Henssen, P.M. Jørgensen & G. Kantvilas in prep.). The true extent of its distribution on the Australian mainland is unknown, and the species is known to us only from a few older herbarium collections from Victoria (Fig. 4).

Morphological variation in the species appears to be related mainly to moisture availability. Individuals from the wettest habitats, such as semi-inundated rocks in stream beds, have a loose, well developed thallus of spreading lobes and discrete thalline strands. In contrast, most individuals from drier sites, such as boulders in eucalypt forest, are very compact and densely granular. The iodine reactions of the hymenium are confined to the hymenial gel enveloping the asci and paraphyses, and the ascus wall itself displays no amyloid reactions. Pycnidia are very obscure or at least difficult to locate in this lichen; all observations recorded were as a result of fortuitous sectioning of many granules and lobe apices. Essentially lobules containing pycnidia are not unlike those with apothecial initials, except that the latter tend to have brownish apices from a very early age. In contrast, pycnidial lobules tend to be a little more black and glossy. Ostioles could not be detected by low-power microscopy, but appear to be both lateral and apical.

Specimens Examined

Tasmania: Central Plateau, Pine Lake, 41°44' S, 146°42' E, on mossy dolerite rocks at edge of alpine stream, 1200 m altitude, *G. Kantvilas 89/82*, 17.iii.1982 (HO); Grass Tree Hill, 42°47' S, 147°21' E, on moss on soil, *G.C. Bratt & G. Degelius 70/399*, 15.iii.1970 (HO); same locality, on sandstone and moss, 320 m altitude. *G.C. Bratt & J.A. Cashin 70/866*, 18.vii.1970 (HO); Nelsons Creek. Orford Rd, 42°36' S, 147°39' E, on dolerite, *G.C. Bratt 73/1348*, 23.xii.1973 (HO); Vale of Belvoir, 41°33' S, 145°53' E, on limestone outcrops in sedgeland, 800 m altitude, *G. Kantvilas 50/93*, 21.v.1993 (HO); same locality, on limestone boulders at the waterline in stream in buttongrass moorland, 840 m, *G. Kantvilas 60/87*, 16.v.1987 (HO); Derwent River near Plenty, 42°44' S, 146°56' E, on soil on dolerite, 15 m altitude, *G.C. Bratt & G. Degelius 70/275*, 12.iii.1970 (HO); top of St Peters Pass, 42°17' S, 147°25' E, on doleritic soil, 465 m altitude, *G.C. Bratt 70/1371*, 22.xi.1970 (HO); summit of Mt Direction, 42°49' S, 147°19' E, on dolerite, 441 m altitude, *G.C. Bratt 72/626*, 8.vii.1972 (HO); track to Projection Bluff, 41°44' S, 146°42' E, on moist dolerite boulders in rainforest, 1200 m altitude, *G. Kantvilas 1/94*, 3.i.1994 (HO); Douglas Creek, Pelion Plains, 41°50' S, 146°03' E, on wet dolerite rocks in stream bed, 900 m altitude, *G. Kantvilas 4/83*, 1.ii.1983 (HO); NE Ridge Track, Mt Anne, 42°56' S, 146°26' E, on wet dolerite rocks in subalpine rainforest, 1040 m altitude, *G. Kantvilas 263/82*, 12.xii.1982 (HO); Ouse River near Liawenee Canal, 41°54' S, 146°37' E, on moss and soil over wet dolerite rocks in alpine woodland, 1080 m altitude, *G. Kantvilas 66/83*, 26.v.1983 (HO); Serpentine Hill near Argent Tunnel, 41°50' S, 145°25' E, amongst mosses on serpentine outcrops in heathland, 360 m altitude, *G. Kantvilas 9/84*, 13.i.1984 (HO); Nugent to Buckland road, 42°39' S, 147°45' E, on dolerite in stream, 200 m altitude, *G.C. Bratt 70/655*, 26.iv.1970 (HO); Broadmarsh to Dromedary road, 42°40' S, 147°10' E, on moss in open grassland, *G.C. Bratt & M.H. Bratt 70/745*, 14.vi.1970 (HO); Logan Road, 41°32' S, 147°21' E, on mossy rocks in light bushland, 340 m altitude, *S.J. Jarman* , 26.vii.1995 (HO); Dunnys Creek, 42° 13' S, 146° 25' E, on mossy dolerite rocks by creek, 640 m altitude, *G. Kantvilas & P.W. James 477/84*, 5.ii.1984 (BM, HO); near Pitts Hill, 42° 37' S, 147° 41' E, on mossy dolerite rocks in open eucalypt forest, 120 m altitude, *G. Kantvilas 32/97*, 29.i.1997 (HO); c. 7 km east of Lake Leake, 42° 01' S,

147° 55' E, on moist rocks in dry sclerophyll forest, 400 m altitude, *G. Kantvilas* s.n., 24.iv.1996 (HO). **Victoria:** Braybrook, 37° 46' S, 144° 51' E, *R.A. Black*, 18.x.1900 (MEL); Kyneton, on rocks in Campaspe River, 37° 19' S, 144° 28' E, *F.R.M. Wilson* , v.1897 (MEL); Preston Reservoir, 37° 43' S, 144° 58' E, *R.A. Black*, 17.xi.1900 (MEL).

Neotypification of Synalissa cancellata

Wilson's type of this species, as with many of his collections, appears to have been lost, presumably as part of the ill-fated loan of type specimens from the National Herbarium of Victoria (MEL) to the University of Messina, Sicily, in 1907 (see Filson 1976). However, an authentic specimen exists in BRI as part of John Shirley's collection of Victorian lichens sent to him by Wilson. Although not mentioned specifically on the specimen itself, Shirley (1894) gives its locality as 'on mossy rocks, Mt Macedon'. This is the same provenance as that of the type, as given in Wilson's prologue, and may even be a part of the type collection. Given this uncertainty, the material is designated here as the neotype rather than the lectotype of *Synalissa cancellata* F. Wilson. It is well developed, typical and with abundant apothecia.

Acknowledgements

We thank Dr S.J. Jarman for identifying the bryophytes mentioned, and for comments on the manuscript, Ms S. Louwhoff for locating specimens in MEL, and Dr M. Wedin and Mrs P. Wolseley for obtaining copies of literature. The loan of specimens from MEL and BRI is gratefully acknowledged.

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Zygnemataceae (Chlorophyta) in Australia: a Reassessment of Records and a Key to Accepted Taxa

Simon H. Lewis and Timothy J. Entwisle

Royal Botanic Gardens, Melbourne, Birdwood Avenue, South Yarra, Vic. 3141, Australia

Abstract

A synopsis and assessment are provided of the 100 specific and subspecific records of Zygnemataceae from Australia. Sixty-eight taxa are represented by a description, an illustration, a photograph and/or a herbarium specimen. Of these, 51 are accepted and included in a preliminary census of the family, the other 17 are rejected. Along with these 17, 32 of the 100 species were insufficiently documented (no description, illustration or herbarium record) to allow assessment. A total of 49 species are therefore rejected from the census. A key is provided to the accepted species.

Introduction

The family Zygnemataceae are represented in a wide range of freshwater habitats throughout Australia and the world. Although 100 species have been reported from Australia (Day *et al.* 1995), there has been no critical study to assess the validity of these records. Few records are well-documented in the literature and/or represented by voucher material in herbaria. In our study, we assessed all literature records, verifying the names used against available literature and where possible, relevant voucher material. The resulting synopsis and assessment are an important and necessary prelude to a thorough revision of the family which must include examination of type material, and extensive collection and culture studies.

Methods

In addition to evaluating all published reports of Zygnemataceae from Australia, we examined some unpublished records and all specimens received from Australian herbaria. We requested on loan all fertile material of Zygnemataceae from PERTH, DNA, AD, BRI, NSW, CANB, CBG and HO. All known literature records (Day *et al.* 1995) and fertile herbarium material from Australia were compared with the available literature. These records are listed under the heading *Specimens Reported* or under *Specimens Examined* if herbarium material was available. Where possible, existing slides were examined or, if necessary, new slides were prepared from herbarium material. The *Description of Australian Specimens* combines all available published information on the taxon in Australia as well as any data obtained from voucher material.

Slides of voucher material were made by placing a drop of a detergent solution on a small section of the dried voucher specimen to enable a few filaments to be lifted off. The filaments were then soaked in an eyeglass of the same solution and warmed on a hot-plate to allow rehydration. They were stained with 1% Aniline Blue (or other appropriate stain) for about ten minutes, washed in a water bath, then left in a drop of 10% Karo ™ Corn Syrup (with 1% phenol) for at least 2 minutes. The filaments were then placed in a drop of 40% Karo ™ Corn Syrup (with 1% phenol)

on a microscope slide where a cover slip was gently placed on top. The cover-slip was weighted down whilst the slide dried.

Species reported by Stephen Skinner (1980, 1983) to occur in Australia are accepted based on his published accounts rather than by examination of the microscope slides lodged at AD. The descriptions provided by McLeod (1975) appear to be based largely on non-Australian literature reports. For this reason we have only included information from McLeod's thesis in the *Description of Australian Specimens* when it is explicitly based on Australian material (e.g. *Mougeotia oblongata*). However, we have accepted her determinations when the data presented are consistent with published descriptions. The subfamilial groups used in Entwisle (1989) were based on vegetative features and can not be compared to species definitions based largely on reproductive structures.

Diagnostic Features

Genera in the Zygnemataceae are distinguished on the basis of gross chloroplast morphology, the conspicuousness of the conjugation tube, and the presence or absence of mucilaginous material in the gametangia following zygospore formation.

Species are distinguished by a combination of vegetative and reproductive features. The most important vegetative characters are the shape and size of cells, and the shape, number and arrangement of chloroplasts. Important reproductive features include: type of conjugation, whether lateral and/or scalariform; the morphology of the conjugation tube; the shape of the gametangia; and the shape and ornamentation of the zygospores. The wall of the zygospore is generally 3-layered and the *middle wall* is most taxonomically important. The *middle wall* is variously coloured and/or ornamented under light microscopy (additional characters are provided by scanning electron microscopy), the *outer wall* is usually colourless and transparent (or sometimes absent, e.g. in *Mougeotia*), and the *inner wall* is thin and usually obscure. Gametangial residues may adhere to zygospores in *Mougeotia*.

Accepted Taxa

From published data and in some cases material examined, we accept the following taxa as present in the Australian flora. That is, the description of the Australian specimens is compatible with the protologue or descriptions provided in major monographs. These names constitute a first census of the Zygnemataceae in Australia.

DEBARYA Wittr.

Vegetative cells with elongate axial chloroplasts extending the length of the cell; zygote not separated from gametangia by special walls; cytoplasmic residue not remaining in the gametangia; sporangia filled with pectic cellulose-colloid.

1. **Debarya hardyi** G.S. West, *J. Linn. Soc., Bot.* 39: 51 (1909).

Known Distribution: Australia.

Specimen Reported: VICTORIA: Yan Yean Reservoir, *G.S. West*, i.1906 (West 1909).

Description of Australian Specimens: Vegetative cells 6.5-7.5 μm in diameter, 9-16 times as long as broad, 2–4 pyrenoids in single series with regular arrangement; conjugation scalariform; zygospores quadrate, sides straight or very slightly concave, sometimes thickened, corners thickened and horned, horns cylindrical and solid; skin of the horn delicate and lamellate.

Taxonomic Assessment: West (1909, 51) states that 'this is the narrowest described [sic] species of the genus *Debarya*, and in outward appearance presents many resemblances to *Mougeotia gracillima*.' Mature spores were absent from the material examined by West (1909), but the chloroplast shape seems typical of the subfamily Mougeotioideae rather than Zygnemoideae and the narrow filaments are diagnostic of this species. Transeau (1951, 77) suggests that 'it is possible that this alga may, when fully known, be placed in *Zygnemopsis*.' The species has not been collected since the type collection.

MOUGEOTIA C. Agardh

Vegetative cells with elongate axial chloroplasts extending the length of the cell; zygote separated from gametangia by special walls; cytoplasmic residue remaining in the gametangia.

2. **Mougeotia acadiana** Transeau, *Trans. Amer. Microscop. Soc.* 53: 224 (1934).

Known Distribution: North America, Europe, Australia.

Specimen Reported: NORTHERN TERRITORY: Alligator River Region, Nankeen Billabong, *H.U. Ling and P.A. Tyler*, 13.iii.1979 (Ling and Tyler 1986).

Description of Australian Specimens: Vegetative cells 265–305 µm long, 23–30 µm in diameter; zygospores brown, with a furrow in the middle and a circular flange at each end.

Taxonomic Assessment: *Mougeotia acadiana* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 100–400 µm long, 43–54 µm in diameter; chloroplasts with numerous scattered pyrenoids; scalariform conjugation; distinctly geniculate gametangia; zygospores cylindrical-ovoid, 57–78 µm long, 51–70(73) µm in diameter, usually with concave sides and convex ends, the smooth and yellow middle wall thickened, wholly within the greatly enlarged conjugation tube. Although the filaments from the Northern Territory are narrower than those reported generally for *M. acadiana*, the shape of the zygospores and position in the conjugation tube matches that species. The illustrations in Ling and Tyler (1986) resembles those of Skuja (1949) and Transeau (1926). However, despite the disparity in size of the vegetative filaments, the Australian material is retained under the name *M. acadiana*. This collection could equally be referred to *M. laetevirens* which it matches more closely in vegetative diameter.

3. **Mougeotia laetevirens** (A. Braun) Wittr. in Wittr. & Nordst., *Bot. Not.* 1877: 23 (1877). *Craterospermum laetevirens* A. Braun, *Alg. Unicell.* 60 (1855).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892, 1895; Bailey 1893, 1895, 1913); Queensland University Lake, St Lucia, *J.A. McLeod*, [s. d.] (McLeod 1975), Stradbroke Island, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Royal Botanic Gardens, Sydney, *G.I. Playfair*, 1916–17; Lismore, *G.I. Playfair*, 1916–17 (Playfair 1918).

Specimen Examined: QUEENSLAND: Big Bend area of Burdekin River, *A.B. Cribb 925.19*, 5.ix.1981 (BRI; Cribb 1984).

Description of Australian Specimens: Vegetative filaments 255–408 µm long, (22–)27–44 µm in diameter; pyrenoids 10–20 per chloroplast, either irregularly scattered or arranged in two lines at the edges, usually small (2–4 µm in diameter) occasionally larger (10 µm in diameter); conjugation scalariform; zygospores ovoid to oblong, rarely globular, 'more or less pulley-wheel form' (Cribb 1984, 103), 40–63

µm long, 42–53 µm in diameter, contained within the conjugation tube, middle wall smooth and yellow-brown (Cribb 1984) or glistening white and stratified (Moebius 1895). The description is taken from published accounts, the herbarium specimen not providing any additional information.

Taxonomic Assessment: *Mougeotia laetevirens* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 65–350 µm long, 34–41 µm in diameter; chloroplasts with numerous scattered pyrenoids; conjugation scalariform; gametangia distinctly geniculate; zygospores, wholly within the conjugation tube, polymorphic, usually short-cylindrical, 45–72(–75) µm long, 36–47(–60) µm in diameter, with concave sides, sometimes compressed-globose or irregular, middle wall smooth and yellow-brown; aplanospores ovoid to obliquely ovoid. Nearly all these features are present in the described Australian material. Furthermore, illustrations, such as Transeau's (1951) of North American representatives of *M. laetevirens*, closely match the Australian material in vegetative and zygospore morphology. Moebius's (1895) description of the middle wall is at odds with all published data from Australia and overseas, but in other respects the specimen described by Moebius is referable to *M. laetevirens*. All Australian literature reports of *M. laetevirens* are accepted.

4. **Mougeotia parvula** Hassall, *Ann. Mag. Nat. Hist.* 11: 434 (1843) var. **parvula**.
Mougeotia parvulus Hassall, *Hist. Brit. Freshwater Alg.* 169, t. 45 figs 2–3 (1845).

Known Distribution: North and South America, Europe, North Africa, Asia, Australia.

Specimen Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917).

Specimen Examined: QUEENSLAND: Blackdown Tableland, *A.B. Cribb 805.1*, 6.ix.1974 (BRI; Cribb 1976).

Description of Australian Specimens: Vegetative cells 40–75 µm long, c. 9 µm in diameter; conjugation scalariform; zygospores (and/or aplanospores) in the conjugating tubes, globose, c. 15 µm in diameter and yellow-brown.

Taxonomic Assessment: *Mougeotia parvula* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 30–140 µm long, 6–13 µm in diameter, chloroplast usually occupying two-thirds of the cell, with 4–8 pyrenoids; conjugation scalariform; zygospores formed wholly in the conjugating tube, globose, 13–25(–36) µm in diameter, middle wall thick, smooth and brown; aplanospores obliquely ovoid, 20–24 µm long, 16–20 µm in diameter. The Queensland collection matches other published descriptions of *M. parvula* and is accepted here and referred to the typical variety (see *Mougeotia parvula* var. *angusta* in rejected names). The listing in Playfair (1917) includes no documentation so the New South Wales collection cannot be verified.

5. **Mougeotia scalaris** Hassall, *Ann. Mag. Nat. Hist.* 10: 45 (1842). *Mesocarpus scalaris* (Hassall) Hassall, *Hist. Brit. Freshwater Alg.* 166 (1845); ?*Zygnema scalare sensu* Kütz., *in litt.* (1882a); *Mougeotia tenuis* Kütz., *Sp. alg.* 446 (1849), *non Mougeotia tenuis* (Cleve) Wittr. (1872).

Known Distribution: Europe, Asia, North Africa, New Caledonia, Australia.

Specimens Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917). VICTORIA: [s. loc.] (Kützing 1882a, 1882b; as *Zygnema scalare* and *Mougeotia tenuis* respectively).

Specimen Examined: QUEENSLAND: Nerang River, *A.B. Cribb 845.4*, 14.vi.1976 (BRI).

Description of Australian Specimens: Vegetative cells c. 40 μm in diameter; conjugation scalariform; gametangia 18–24 μm in diameter; zygospores formed wholly in the conjugation tube; globose c. 30 μm in diameter. Slide preparations from the herbarium material did not provide additional information.

Taxonomic Assessment: *Mougeotia scalaris* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 40–180 μm long, 20–34 μm in diameter; chloroplast with 4–10 pyrenoids in a single straight or slightly curved row; gametangia straight or slightly curved, 20–34 μm in diameter; conjugation scalariform; zygospores formed wholly in the conjugation tube, ovoid to globose, 27–40 μm long, 25–31 μm in diameter, middle wall smooth and yellow-brown. The Queensland material examined matches the current literature descriptions and is therefore retained under *M. scalaris*. The Playfair (1917) and Kützing (1882a, 1882b) reports include no documentation and cannot be evaluated (De Toni 1889 treats *Mougeotia tenuis* Kütz. as a synonym of *M. scalaris*)

6. **Mougeotia sestertisignifera** Stephen Skinner, *Trans. & Proc. Roy. Soc. South Australia* 107: 223–230 (1983).

Known Distribution: Australia.

Specimen Reported: SOUTH AUSTRALIA: SA Region 13, Bool Lagoon, *J. Roberts and K. Preace*, 5.xi.1982 (Skinner 1983).

Description of Australian Specimens: Vegetative filaments 70–200 μm long, 22–26 μm diameter, end-walls plane; (4–)5–10 scattered pyrenoids; conjugation scalariform; zygospores in broad conjugation tube with arms extending almost to fill both gametangia, H-shaped, 60–80 μm in diameter, outer wall smooth, middle wall lamellate and golden.

Taxonomic Assessment: *Mougeotia sestertisignifera* was newly described in Australia by Skinner in 1983. Skinner (1983, 225) notes that in having an 'H-shaped spore, this taxon is similar to members of the genus *Temnogametum* but does not appear to have specialized smaller gametangial cells, nor does its spore show a sigmoid process.' Vegetatively the material is similar to *Mougeotia* species with quadrate spores.

7. **Mougeotia subcrassa** G.S. West, *J. Linn. Soc., Bot.* 39: 50 (1909).

Known Distribution: Australia.

Specimen Reported: VICTORIA: Yan Yean Reservoir, *G.S. West*, x–xi.1905 (West 1909).

Description of Australian Specimens: Vegetative cells 41.5–43 μm in diameter, 6–6.5 times longer than broad; chloroplasts large, with 15–24 pyrenoids; conjugation scalariform, conjugation tube straight or very slightly curved; zygospores globose, 40–41 μm in diameter, middle wall smooth.

Taxonomic Assessment: The relatively small size of spores as compared with the diameter of the vegetative cells distinguishes this species from *M. scalaris* and *M. crassa* (West 1909). It is also distinguished from the former by the much greater thickness of its vegetative cells and large chloroplasts with more numerous pyrenoids; and from the latter by its slightly longer and thinner vegetative cells. It is known only from the type collection.

8. **Mougeotia victoriensis** G.S. West, *J. Linn. Soc., Bot.* 39: 51 (1909).

Known Distribution: Australia.

Specimens Reported: QUEENSLAND: Toonpan Creek, *M. Laird*, 18.vi.1954 (Laird 1956). VICTORIA: Yan Yean Reservoir, *G.S. West*, xi.1905 (West 1909).

Description of Australian Specimens: Vegetative cells 11.5–12 μm in diameter, 9.5–14 times as long as broad; chloroplasts elongate, with 2–7 (usually 5–6) pyrenoids arranged in a single series; conjugation scalariform; gametangia bent;

zygospores formed in conjugating tube, globose, 21–24 µm in diameter, middle wall smooth; pectic material developing around sporangium and beyond the outer sides of the gametangia, entire mucus coat 60–63 µm in diameter.

Taxonomic Assessment: Mougeotia victoriensis is similar to *M. parvula* but is distinguished by its slightly thicker, somewhat elongate, vegetative cells and by the large (almost three times the diameter of the spore) gelatinous envelope surrounding the spores West (1909). The Queensland report Laird (1956) includes no documentation and cannot be verified. The type collection therefore remains the only confirmed record.

SPIROGYRA Link

Vegetative cells with 1-several parietal, spiral chloroplasts; conjugating tubes formed by one or both gametangia before conjugation; outer layer of vegetative cell walls made of pectic compounds, which usually disappear during conjugation.

9. Spirogyra australiensis Moebius, *Abh. Senckenberg. Naturf. Ges.* 18: 310–50 (1895).

Known Distribution: Australia.

Specimens Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1895; Bailey 1895, 1913; Pigram 1909); Capalaba and lagoon east of Maryborough, *J.A. McLeod,* [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells c. 50 µm in diameter, 2–3 times as long as broad, end-walls plane; chloroplasts single with 2.5–3 revolutions; gametangia as long as, or generally longer than vegetative cells, not swollen, the conjugation canal issuing from the male filament is longer than that issuing from the female filament; zygote ovoid, 74–77 µm long, 40–45 µm in diameter, with a 'thin, internal, hyaline membrane and an external thicker one, finely verrucose and dusky green.' Bailey (1895, 34).

Taxonomic Assessment: *Spirogyra australiensis* is similar to *S. velata* and *S. dædalea* but differs in vegetative cell and zygote morphology. It also resembles *S. punctata* but differs in the gametangial morphology. All Australian reports are based on the type collection.

10. Spirogyra baileyi W. Schmidle, *Flora* 82: 297 (1896).

Known Distribution: Brazil, Africa, Australia.

Specimens Reported: QUEENSLAND: Enoggera district, *W. Schmidle*, 27.iv.1895 (Schmidle 1896; Bailey 1898, 1913); Bardon and Gympie, *J.A. McLeod,* [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells 128–200 µm long, 20–24 µm in diameter, end-walls plane; chloroplasts 2, 'fairly broad', with 3–4 revolutions; conjugation tubes formed by both gametangia; gametangia shorter than vegetative cells, rather strongly inflated, c. 60 µm long, c. 32 µm in diameter; zygotes elliptical, c. 48–53 µm long, 26.5–28 µm in diameter, middle wall smooth.

Taxonomic Assessment: The diagnostic features of the species, according to Schmidle (1896), are the long and narrow vegetative cells and the two chloroplasts per cell. The type of *Spirogyra baileyi* is Australian and the taxa is recognized in all major monographs. It has since been found in Africa (Gauthier-Liévre 1965) and Brazil (Dias 1992).

11. Spirogyra bellis (Hassall) Cleve, *Nova Acta Regiae Soc. Sci. Upsal.* ser. 3, 6: 18 (1868). *Zygnema belle* Hassall, *Hist. Brit. Freshwater Alg.* t. 24 (1845); *Spirogyra subaequa* Kütz., *Phycol. Germ.* 223 (1845), equated with *S. bellis* by De Toni (1889).

Known Distribution: North America, Africa, India, Australia.

Specimens Reported: QUEENSLAND: Port Curtis, *T.L. Bancroft*, v–vi.1892 (Bailey

1895, 1913; Moebius 1895; Pigram 1909); Elliot Heads and Capalaba, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: [s. loc.] (Kützing 1882b, as *Spirogyra subaequa*).

Description of Australian Specimens: Vegetative cells 65–70 µm in diameter, 3–4 times as long as broad, end-walls plane; chloroplasts 4–5, nearly straight or making up to 2 spirals.

Taxonomic Assessment: *Spirogyra bellis* is characterized (Borge 1913; Transeau 1951; Gauthier-Liévre 1965; Kadłubowska 1972; Dillard 1990) by vegetative cells 90–350 µm long, 65–80 µm in diameter, with plane end-walls; 5-6 chloroplasts making 0.1–1 turn; conjugation tubes formed equally by both gametangia; gametangia shortened or inflated; zygospores lenticular, 60–90(–105) µm long, (45–)48–60 µm in diameter, outer spore wall thickened, smooth and colourless, middle wall thickened, irregularly pitted and brown. Randhawa (1959), however, describes *S. bellis* as having vegetative cells 60–65 µm in diameter, with up to 7 chloroplasts, zygospores oval or globose, 80–85 µm long, 54–64 µm in diameter, with the middle wall smooth, thick, brownish yellow in colour, and gametangia strongly swollen on both sides. The cell dimensions and number of chloroplast spirals in the vegetative filament illustrated by Pigram (1909; the fertile filament is after Petit 1880) do not match the above descriptions and his record is therefore excluded. Moebius (1895, as translated in Bailey 1895, 36) describes his specimen as having filaments '...distinguished by a thick gelatinous sheath (as much as 100 µm thick) and this together with the agreement in dimensions and other characteristics makes the determination pretty certain.' Pigram (1909) did not observe such a sheath in his specimens, commenting that 'it is probably not persistent.' This feature is not mentioned in any of the above descriptions and we discount it as a diagnostic character for this species. In the absence of reproductive material, the Brancroft specimen could be referable to other species of *Spirogyra*, such as *S. echinospora* Blum. The Victoria record is not documented, and is also excluded from the census. The description provided by McLeod (1975), however, is consistent with other descriptions of this taxon and the name is accepted in this census.

12. Spirogyra columbiana Czurda, *Süsswasserflora* 9: 190 (1932). *Spirogyra neglecta* var. *amylacea* Playfair, *Proc. Linn. Soc. New South Wales* 43: 497–543 (1918).

Known Distribution: North and South America, Europe, South Africa, Asia, Australia.

Specimen Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1916–1918 (Playfair 1918).

Description of Australian Specimens: Vegetative cells 60–260 µm long, 46–54 µm in diameter, end-walls plane; chloroplasts 2–3, making 1.5–3.5 turns; pyrenoids up to 10–12 µm in diameter; zygospores ellipsoid, 74–90 µm long, 48–50 µm in diameter.

Taxonomic Assessment: *Spirogyra neglecta* var. *amylacea* is listed by Kadłubowska (1972) as a synonym of *S. columbiana* Czurda and the description he gives is generally consistent with that of Playfair (1918). *Spirogyra columbiana* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 90–180 µm long, 46–54 µm in diameter, with plane end-walls; chloroplasts 1–3; conjugation scalariform, conjugation tubes formed equally by both gametangia; fertile and sterile cells both cylindrical; zygospores ellipsoid, 59–124 µm long, 42–70 µm in diameter, middle wall thickened, smooth and yellow-brown with a distinct suture. Playfair (1918, 513) commented that 'the chloroplasts have become impregnated with amylum and have broken up into minute irregular grains. The central ridge, however, is generally still noticeable.'

13. Spirogyra communis (Hassall) Kütz., *Sp. alg.* 439 (1849). *Zygnema commune* Hassall, *Hist. Brit. Freshwater Alg.* 148, t. 28 fig. 5–6 (1845).

Known Distribution: North and South America, Europe, North Africa, Asia, New Caledonia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: [s. loc., s. d.] (Pigram 1909); Mt Tambourine, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Hawkesbury River, *F. Mueller*, [s. d.] (Kützing 1882b).

Specimen Examined: QUEENSLAND: Lower Dry Creek, Kroombit Tops, *A.B. Cribb 985.2*, 11.xii.1983 (BRI; Cribb 1986).

Description of Australian Specimens: Vegetative cells 4–6(–12) times as long as broad, end-walls plane; chloroplast single, making 3–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia inflated on the conjugating side; zygospores lenticular to elliptical (calculated from illustration in Pigram 1909).

Vegetative cells 87–100 µm long, 25 µm in diameter, end-walls plane; chloroplast single, making 2.5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; zygospores ellipsoid, c. 48 µm long, c. 24 µm in diameter; middle wall smooth and yellow-brown (BRI).

Taxonomic Assessment: *Spirogyra communis* is chàracterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Devi and Panikkar 1993) by vegetative cells (18–)19–25(–26) µm in diameter, 2–5 times as long, with plane end-walls and chloroplast single, making 1.5–4 turns; conjugation scalariform (occasionally lateral), conjugation tubes formed equally by both gametangia; gametangia cylindrical (rarely enlarged); zygospores ellipsoid, 35–69(–78) µm long, 18–23(–26) µm in diameter, outer spore wall thin, smooth and colourless, middle wall thickened, smooth and yellow to brown. Pigram's (1909) description and illustration do not match other published descriptions of *S. communis* and this report is excluded. So too is the report of Kützing (1882b), which includes no documentation and is not vouchered. However, the McLeod and Cribb collections from Queensland match the above description of *S. communis* and the name is retained in the census.

14. Spirogyra cylindrica Czurda, *Süsswasserflora* 9: 150 (1932).

Known Distribution: North America, Europe, Africa, China, Australia.

Specimen Reported: QUEENSLAND: Big Bend area of Burdekin River, *A.B. Cribb*, vi-vii.1981 (Cribb 1984).

Description of Australian Specimens: Vegetative cells 10–17.5 µm diameter, end-walls replicate; chloroplast single; conjugation scalariform, conjugation tube formed mainly by male gametangium; gametangia inflated on the conjugating side; zygospores ellipsoid, 25–28 µm in diameter, middle wall entirely smooth, yellow-brown.

Taxonomic Assessment: *Spirogyra cylindrica* is characterized (Czurda 1932; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Kargupta and Sarma 1992) by vegetative cells (91–)140–350 µm long, 9–19 µm in diameter, with replicate end-walls; chloroplast single, making 2.5–6 turns in the cell; conjugation lateral and scalariform, conjugation tubes formed almost wholly by the male gametangia; gametangia inflated towards the centre to 28–42 µm; zygospores ellipsoid 33–71(–95) µm long, 19–38 µm in diameter, middle wall smooth, and yellow-brown, The Australian report is concordant with this description and the name *S. cylindrica* is accepted here.

15. Spirogyra decimina (O.F. Müll.) Kütz., *Phycol. General.* 279 (1843). *Conferva decimina* O.F. Müll., *Nova Acta Acad. Sci. Imp. Petrop. Hist. Acad.* 3: 94, t. 2 fig. 3 (1785).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: Corinda, *C.T. White* (Bailey 1913); Indooroopilly, Bardon, Jimboomba, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: [s. loc.], *Watts* (Hardy 1906; Kützing 1882a, 1882b; Watts 1887).

Specimen Examined: SOUTH AUSTRALIA: Adelaide, Torrens River, *F. Mueller*, i.1848 (MEL; Sonder 1852, 1880; Tate 1882).

Description of Australian Specimens: Vegetative cells 60-90 μm long, 25–45 μm in diameter. The specimen examined was poor and the cell contents have degenerated. Mueller's collections were determined by Kützing.

Taxonomic Assessment: *Spirogyra decimina* is characterized (Transcau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 66–150 μm long, 32–42 μm in diameter, with plane end-walls; 2–3 chloroplasts making 1–2 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical or enlarged; zygospores ovoid to globose, 31–68(–73) μm long, 31–41 μm in diameter, middle wall smooth, yellow. Although the herbarium material examined (originally determined by Kützing) was consistent with the above description, it was sterile and could be referred to one of many species. Similarly, the literature reports for Victoria were determined from sterile material and cannot be assigned confidently to *S. decimina.* The Corinda record is not documented at all by Bailey (1913). However, the description provided by McLeod (1975) is consistent with this taxon and the name is accepted in this census. This species cannot be distinguished from *S. rivularis* in the vegetative condition.

16. Spirogyra ellipsospora Transeau, *Amer. J. Bot* 1: 294 (1914).

Known Distribution: North America, Central China, India, Australia.

Specimen Reported: NORTHERN TERRITORY: Alligator River Region, Jabiluka Billabong, *H.U. Ling and P.A. Tyler*, 4.vi.1979 (Ling and Tyler 1986).

Description of Australian Specimens: Vegetative cells cylindrical, 180–305 μm long, 110–120 μm in diameter, end-walls plane; chloroplasts 5, making many turns; conjugation scalariform, conjugation tubes from both gametangia, zygospores 195–203 μm long, 100–104 μm in diameter, ellipsoid or cylindrical-ellipsoid, middle wall smooth and yellow-brown.

Taxonomic Assessment: *Spirogyra ellipsospora* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 125–500 μm long, 125–150 μm in diameter, with plane end-walls; chloroplasts 3–8 making 4–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia, gametangia cylindrical; zygospores ellipsoid, apices more or less pointed, 160–255 μm long, 100–140 μm in diameter; outer spore wall thin, smooth and colourless, middle wall smooth and yellow-brown. The Australian specimen matches this description and is therefore accepted under the name *S. ellipsospora.*

17. Spirogyra farlowii Transeau, *Ohio J. Sci.* 16: 29 (1915). *Spirogyra grevilleana* var. *australis* Playfair, *Proc. Linn. Soc. New South Wales* 40: 310-62, pl. 42 fig. 2 (1915).

Known Distribution: North America, Europe, Asia, Australia.

Specimens Reported: NEW SOUTH WALES: Lismore, Wyrallah Road, *G.I. Playfair*, 1914 (Playfair 1915, 1917). TASMANIA: Freshwater Creek, Bakers Beach, Sorell, *H.J. Robertson*, 5.ix.1982 (unpublished illustration and description with AD *53982*).

Description of Australian Specimens: Vegetative cells 160–230 μm long, 30 μm in diameter, 5–15 times as long as broad, end-walls replicate; chloroplasts 1(–2) making 2.5–7 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia enlarged; zygospores ellipsoid, with pointed ends, c. 75 μm long, c. 50 μm in diameter.

Taxonomic Assessment: *Spirogyra farlowii* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 70–400 μm long, 23–30 μm in diameter, with replicate end-walls; 1 (rarely 2) chloroplast

making 2.5–6 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia inflated to 39–60 μm; zygospores and aplanospores ellipsoid, ends more or less pointed, 48–96 μm long, 30–45 μm in diameter, middle wall smooth and yellow. Skinner (*in sched.*) made a comment on the specimen [AD *A53982*] that it 'is thought (Kek) to be equivalent to Playfair's (1915) *Spirogyra grevilleana* var. *australis* from the Richmond River near Lismore, NSW.' *Spirogyra grevilleana* var. *australis* is listed as a synonym of *S. farlowii* in Kadłubowska (1972), and both Australian records are consistent with the description above. *S. farlowii* is thus included in our census.

18. Spirogyra fennica Cedercr., *Acta Soc. Fauna Fl. Fenn.* 55(2): 4 (1924).

Known Distribution: North America, Europe, South Africa, Asia, Australia.

Specimen Examined: QUEENSLAND: Bertie Creek, Cape York Peninsula, *A.B. Cribb 1188.6*, 10.iii.1992 (BRI).

Description of Australian Specimens: Vegetative cells c. 126 μm long, c. 21 μm in diameter, end-walls plane; chloroplast single, making up to 4 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia greatly inflated, 30–42 μm in diameter; zygospores ellipsoid, 48–63 μm long, 27–30 μm in diameter.

Taxonomic Assessment: *Spirogyra fennica* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 60–260 μm long, 15–21 μm in diameter, with plane end-walls; chloroplast single; conjugation scalariform (sometimes lateral), conjugation tubes formed equally by both gametangia; gametangia shortened and inflated to 34–39 μm in diameter; zygospores ellipsoid, 45–58 μm long, 24–31 μm in diameter, middle wall smooth and yellow-brown. The Australian collection is concordant with this description and the name *S. fennica* is accepted in our census.

19. Spirogyra frigida F. Gay, *Essai Monogr. Conjug.* 90, t. iv fig. 4 (1884).

Known Distribution: Europe, Asia, Australia.

Specimen Reported: SOUTH AUSTRALIA: Ibis rookery, Bool Lagoon, *L. Lloyd*, 15.ix.1982 (Skinner 1983)

Description of Australian Specimens: Vegetative cells (16–)18–23 μm in diameter, 4–10 times as long as broad, end-walls replicate; chloroplast single, making 5–9 turns, pyrenoids numerous; conjugation scalariform, gametangial tube almost cylindrical, unequal, inflated towards the gametangial tube; zygospores elliptical, 70–75 μm, 35 μm in diameter, middle wall smooth and pale-brown.

Taxonomic Assessment: *Spirogyra frigida* is characterized (Kadłubowska 1972, 1984) by vegetative cells sometimes swollen, 16–20 μm in diameter, 3.5–12 times as long as broad, end-walls replicate; chloroplast single; conjugation scalariform, gametangia enlarged, conjugation tubes normally formed equally by both gametangia; zygospores ellipsoid, attenuated, 48–103 μm long, 20–35 μm in diameter, middle wall smooth and yellow. The Australian specimen closely matches the descriptions of *S. frigida* by Kadłubowska and this name is accepted in the census.

20. Spirogyra grevilleana (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema grevillii* Hassall, *Hist. Brit. Freshwater Alg.* 149, pl. 31 figs 1, 2 (1845); *Spirogyra quinina* var. *inaequalis* Sonder *nom. nud.* (1880).

Known Distribution: North America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: [s. loc., s. d.] (Pigram 1909); Sandgate Lagoon and Gympie, *J.A. McLeod*, [s. d.] (McLeod 1975). TASMANIA: [s. loc., s. d.] (Sonder 1852, as '*S. quinina* b *inaequalis*'; Sonder 1880).

Description of Australian Specimens: Vegetative cells 28–41 µm in diameter, 5 times as long as broad, end-walls replicate; chloroplast single, making 3 turns; conjugation scalariform, conjugation tubes formed by both gametangia, sometimes mostly by the male, vegetative cells of the conjugating filament not swollen, gametangia inflated, fusiform; zygospores ellipsoid (calculated from illustration in Pigram 1909).

Taxonomic Assessment: *Spirogyra grevilleana* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 60–325 µm long, 22–33 µm in diameter; with replicate end-walls; chloroplast 1 (sometimes 2), making 4–8 turns; conjugation scalariform and lateral, conjugation tubes formed largely by male gametangia; gametangia fusiform 'inflated' 36–43 µm in diameter; zygospores globose to ovoid, (35–)60–90 µm long, 30–42 µm in diameter, outer spore wall thin, smooth and colourless, middle wall smooth and yellow often with a distinct fissure-line. Although with filaments generally broader than reported elsewhere, the Queensland records are consistent with *S. grevilleana* and the name is accepted here. The reports by Sonder are not documented and cannot be evaluated here.

21. Spirogyra inflata (Vaucher) Kütz., *Phycol. General.* 279 (1843). *Conjugata inflata* Vaucher, *Hist. Conferv. Eau Douce* 68, t. 5 fig. 3 (1803).

Known Distribution: North America, Europe, North Africa, Asia, Australia.

Specimens Reported: NORTHERN TERRITORY: Alligator River Region, Umbungbung Billabong, *H.U. Ling and P.A. Tyler*, 30.v.1979 (Ling and Tyler 1986). QUEENSLAND: Upper Walsh River, *T.L. Bancroft* (Bailey 1913; Borge 1911); Upper Brookfield, and Reynolds Creek, *J.A. McLeod*, [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells c. 103 µm long, 17–20 µm in diameter, end-walls replicate; chloroplasts single; conjugation scalariform; conjugation tubes formed equally by both gametangia; gametangia inflated, fusiform; zygospores ellipsoid, smooth, 50–56 µm long, 26 µm in diameter.

Taxonomic Assessment: *Spirogyra inflata* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 45–230 µm long, 15–21 µm in diameter, with replicate end-walls; chloroplast single, making 2.5–6 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia, gametangia inflated, 35–48 µm in diameter; zygospores and aplanospores ellipsoid, 50–76 µm long, 27–36 µm in diameter, middle wall thickened, smooth and yellow. These features are consistent with records documented by McLeod (1975) and Ling and Tyler (1986), and the name *S. inflata* is retained here. Bancroft's (Bailey 1913; Borge 1911) report of the species includes no documentation or illustration and cannot be assessed.

22. Spirogyra irregularis Nägeli in Kütz., *Sp. alg.* 440 (1849).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimen Reported: SOUTH AUSTRALIA: Region 13, Bool Lagoon, *L. Lloyd*, 15.ix.1982 (Skinner 1983).

Description of Australian Specimens: Vegetative cells 24–30 µm in diameter, 2–8 times as long as broad, end-walls lenticular; chloroplasts 2–3, making 3–7 turns, pyrenoids numerous; conjugation scalariform, conjugation tubes cup-shaped and of almost equal halves, often arising towards ends of cells; gametangia not inflated; zygospores smooth, slightly compressed ovoid, 75–85(–90) µm long, 30 µm in diameter, middle wall dark yellow-brown.

Taxonomic Assessment: *Spirogyra irregularis* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dias 1992; Habib 1993) by vegetative cells 65–250 µm long, 32–37 µm in diameter, with plane end-walls;

chloroplasts 2–4, making 0.5–1 turn; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical; zygospores ellipsoid to cylindrical-ellipsoid, 45–90 µm long, 30–36(–39.5) µm in diameter, middle wall smooth and yellowish-brown. Although the specimens reported from Australia have slightly narrower filaments and chloroplasts more spiralled, in all other respects it matches *S. irregularis* and the name is accepted here.

23. Spirogyra juergensii Kütz., *Phycol. germ.* 222 (1843).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimen Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917).

Specimen Examined: QUEENSLAND: Surveys Gulley, Lake Broadwater, *A.B. Cribb 1028.1*, 27.i.1985 (BRI; Cribb 1988).

Description of Australian Specimens: Vegetative filaments 54–300 µm long, 23.5–33 µm in diameter, end-walls plane; chloroplast single, making 4–7 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical or often somewhat inflated on the conjugating side; zygospores ellipsoid 47–66 µm long, 30–36 µm in diameter, middle wall smooth and golden.

Taxonomic Assessment: *Spirogyra juergensii* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992; Devi and Panikkar 1993) by vegetative cells 60–207 µm long, 24–33 µm in diameter, with plane end-walls; chloroplast single, making 2–5 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia and distended at the points of contact; gametangia cylindrical or enlarged toward the middle (to 34 µm); zygospores and aplanospores ellipsoid, (41–)50–75(–99) µm long, (22–)28-33 µm in diameter; outer spore wall thin, smooth and colourless, middle wall thicker, smooth and yellow. The Australian collections vary only slightly from this description and the name *S. juergensii* is accepted here.

24. Spirogyra longata (Vaucher) Kütz., *Phycol. General.* 279 (1843). *Conjugata longata* Vaucher, *Hist. Conferv. Eau Douce* 71, pl. 6 fig. 1 (1803).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Glasshouse Mountains, *T.L. Bancroft*, ix.1892 (Bailey 1895, 1913; Moebius 1895); [s. loc., s. d.] (Pigram 1909); Civil Airfield, Cairns, *M. Laird*, 9.vi.1954 (Laird 1956); Upper Brookfield, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Hawkesbury River, *F. Mueller*, 1882 (Kützing 1882b; Playfair 1917). VICTORIA: Berwick, *A.D. Hardy*, 12.v.1906 (Hardy 1906).

Specimen Examined: VICTORIA: Merri Creek, *R.A. Bastow*, ii.1899 (MEL).

Description of Australian Specimens: Vegetative cells 24–26 µm in diameter, 10 times as long as broad, end-walls plane, chloroplast single, making 4–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia, gametangia short, somewhat inflated, zygospores ovoid, somewhat elongated, c. 60 µm long, 22–44 µm in diameter, with rounded ends.

Taxonomic Assessment: *Spirogyra longata* (var. *longata*) is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992; Devi and Panikkar 1993) by vegetative cells 45–280 µm long, 26–38 µm in diameter, 2–10 times as long as broad with plane end-walls; chloroplast single, making 2–5 turns (0.5–1 turn; Kargupta and Sarma 1992); conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia, gametangia not swollen; zygospores ovoid to ellipsoid, sometimes globose, 50–83 µm long, 28–38 µm in diameter, middle wall smooth and yellow (usually

with a distinct fissure line; Dillard 1990). This description matches that of Moebius (1895) except for the non-inflated gametangia. Moebius (1895, as translated in Bailey 1895, 33) noted this one discrepancy but decided that the Bancroft specimen was 'more like [*S. longata*] than any other species.' We concur with this decision. McLeod's description is consistent with *S. longata* and it also is accepted here. The other collections are not sufficiently well documented to assess. This species is similar to *S. singularis*.

Spirogyra longata var. *elongata* Rab. has narrower, longer cells (22–24 µm in diameter, 4–12 times as long as broad) than the type and some Australian collections may be referable to this variety.

25. Spirogyra maxima (Hassall) Wittr., *Bot. Not.* 57 (1882). *Zygnema maximum* Hassall, *Ann. Mag. Nat. Hist.* 10: 36 (1842); *Spirogyra orbicularis* (Hassall) Kütz. *Sp. alg.* 442 (1849); *Spirogyra alternata* Kütz., *Sp. alg.* 442 (1849); *Zygnema alternatum* Hassall, *Hist. Brit. Freshwater Alg.* 139, pl. 20 (1845); *Spirogyra orbicularis, Spirogyra alternata* and *Zygnema alternatum* equated with *Spirogyra maxima* by De Toni (1889).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: [s. loc. , s. d.] (Pigram 1909). NEW SOUTH WALES: Tamworth, *D.A. Poster*, 1885 (Nordstedt 1886); Lismore, *G.I. Playfair*, xii.1912-i.1913 (Playfair 1914, 1917); Bardon, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: [s. loc.] (Watts 1865, as *Zygnema alternatum*; Kützing 1882b, as *Spirogyra alternata*). TASMANIA: [s. loc.], *Stuart*, xii.1848 (Sonder 1852, 1880, both as *Spirogyra orbicularis*).

Description of Australian Specimens: Vegetative cells 120–340 µm long, 108–130 µm in diameter, end-wall plane, lateral walls 1–4 µm thick; chloroplasts 6, making 0.5–1(–3; Playfair 1914) turns; zygospores lenticular, 110–112 µm in diameter or ellipsoid-lenticular, 112–136 µm long, 100–116 µm wide and 84–92 µm thick.

Taxonomic Assessment: *Spirogyra maxima* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Habib 1993; Devi and Panikkar 1993) by vegetative cells 100–250 µm long, 114–140(–155) µm in diameter, with plane end-walls; chloroplasts (5–)6–7, making 0.2–0.8 of a turn; conjugation scalariform, conjugation tubes formed equally by both gametangia, gametangia cylindrical; zygospores lenticular, 100–140(–160) µm in diameter, 64–98 µm thick, outer wall thin, smooth and colourless, middle wall thickened, reticulate, finely punctate and golden-brown. The descriptions of Playfair (1914) and McLeod (1975), and the illustration of Pigram (1909) are consistent with this description of *S. maxima* and we believe the species occurs in Australia. The Kützing (1882b), Nordstedt (1886) and Sonder (1852; 1880) references include no documentation and can not be confirmed.

26. Spirogyra mirabilis (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema mirabile* Hassall, *Hist. Brit. Freshwater Alg.* 156, pl. 35 fig. 1-3 (1845).

Known Distribution: North America, Europe-Asia, Australia.

Specimens Reported: SOUTH AUSTRALIA: Hacks Lagoon, Cons. Pk, *L. Lloyd*, 15.ix.1982 (Skinner 1983); Noarlunga Ford, Onkaparinka River, *B.P. Thomas and S. Skinner*, 14.x.1971 (Skinner 1983). NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1916-1918 (Playfair 1918).

Description of Australian Specimens: Vegetative cells 230–245 µm long, 15–23 in diameter, end-walls plane; chloroplast single, making 3.5–4 turns; conjugation scalariform; gametangia swollen, 25–42 µm in diameter; zygospores ellipsoid, 44–93 µm long, 21–34 µm in diameter (Playfair 1918).

Vegetative cells 28–32 µm in diameter, 2.5–7 times as long as broad, end-walls plane; chloroplast single, making 4–8 turns, with numerous large pyrenoids; 'aplanospores (parthenospores?) in series, spherical to ellipsoid', 27–45 µm long, 28–34 µm in diameter, middle wall smooth walled and golden; 'sporangial cell wall sometimes with an arrested gametangial tube' (Skinner 1983, 226).

Taxonomic Assessment: *Spirogyra mirabilis* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 70-200 µm long, (18–)21–33 µm in diameter, with plane end-walls; chloroplast single, making 4–7 turns; reproduction by aplanospores or very rarely by scalariform conjugation, conjugation tubes formed equally by both gametangia, sporangia enlarged or inflated; aplanospores and zygospores ovoid, less frequently ellipsoid, (33–)50–83(–88) µm long, 23–29(–45) µm in diameter, middle wall smooth and yellow-brown. The report by Skinner is consistent with this description and his records are therefore accepted as *S. mirabilis*. However, the vegetative cells described by Playfair (1918) are longer and slightly narrower than those reported generally for *S. mirabilis* and his description could apply equally to other species such as *S. fennica*; this record is not accepted here.

27. Spirogyra moebii Transeau, *Trans. Amer. Microscop. Soc.* 53: 225 (1934). *Spirogyra maxima* var. *minor* Moebius, *Abh. Senckenberg. Naturf. Ges.* 18: 334 (1895).

Known Distribution: North America, Brazil, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: Dalby, Darling Downs, *T.L. Bancroft*, v.1893 (Moebius 1895, Bailey 1895, 1913; all as *Spirogyra maxima* var. *minor*; Grimes 1988); Canungra and Mt Alford, *J.A. McLeod*, [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells 160–240 µm long, 78–80 µm in diameter, 2–3 times as long as broad, end-walls plane; chloroplasts 6–8, making 0.5–1 turn; gametangia not swollen, shorter than vegetative cells; conjugation scalariform, conjugation tubes formed equally by both gametangia; zygospores lenticular, c. 80 µm in diameter, middle wall golden-brown.

Taxonomic Assessment: *Spirogyra moebii* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 130–240 µm long, 77–118 µm in diameter, with plane end-walls; chloroplasts 6–8, making 0.5–1 turn; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical; zygospores lenticular, 70–103 µm long, 50–75 µm in diameter, middle wall reticulate and yellow-brown. The change of rank for this taxon has been accepted by all authors cited above, and as the type is from Australia the species is accepted here.

28. Spirogyra neglecta (Hassall) Kütz., *Sp. alg.* 441 (1849). *Zygnema neglectum* Hassall, *Hist. Brit. Freshwater Alg.* 142, pl. 23 fig. 1, 2 (1845).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimen Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1916-1918 (Playfair 1918).

Description of Australian Specimens: Vegetative cells 50–360 µm long, 46–64 µm in diameter, end-walls plane; chloroplasts 3–5, each with a central ridge, making 1–3 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical or inflated. 46–57 µm in diameter; zygospores ovoid to elliptical, 52–91 µm long, 42–51 µm in diameter.

Taxonomic Assessment: *Spirogyra neglecta* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Dias 1992; Kargupta and Sarma 1992) by vegetative cells 100–300 µm long, (50–)55–67 µm in diameter, with plane end-walls; chloroplasts 3, making 1–2.5 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia inflated, zygospores and aplanospores ovoid, sometimes orientated at right angles to the filament, 75–100 µm long, 54–64 µm in diameter, middle wall smooth and yellow. Although the dimensions of the Australian material are slightly different to those reported generally for *S. neglecta*, Playfair's taxon is more like *S. neglecta* than any other described species. Playfair (1918) described a number of variants of this species. The description above is based on the combined data from all these except *Spirogyra neglecta* var. *amylacea* which is now referred to *S. columbiana*.

29. Spirogyra nitida (Dillwyn) Link, *Handbuch* 3: 262 (1883). *Conferva nitida* Dillwyn, *Brit. Conferv.* 4: 49 (1809); *Spirogyra princeps* (Vaucher) Cleve, *Fors. Svenska Zygnnem.* 16, pl. 1 figs 4-7 (1868), equated with *Spirogyra nitida* by De Toni (1889).

Known Distribution: North America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: NORTHERN TERRITORY: Standly Chasm, MacDonnell Range, *J.H. Simmonds*, 1.vi.1978 (Cribb 1983). QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1895; Bailey 1895, 1913; Pigram 1909); Gympie and Isis, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917). VICTORIA: Botanic Gardens lake, *A.D. Hardy*, 12.v.1906 (Hardy 1906); Gippsland (Kützing 1882b); [s. loc.] (Kützing 1882b, as '*Sirogonium princeps*' (presumably = *Spirogyra princeps*)).

Specimen Examined: QUEENSLAND: Shallow pool, Botanic Gardens, Brisbane, *G.E. Burrows*, 30.v.1976 (BRI).

Description of Australian Specimens: Vegetative cells 60–65 µm in diameter, 5–6 times as long as broad, end-walls plane; chloroplasts 4, making 2 turns; gametangia slightly swollen and somewhat shorter than vegetative cells; zygospores ovoid with attenuated ends, 90–117 µm long, 55–65 µm in diameter; outer wall thick, colourless, middle wall thin, smooth and chestnut-brown (published data).

Vegetative cells 60–120 µm long, 75–90 µm in diameter, end-walls plane; chloroplasts 2, making 1.5(–2) turns; conjugation lateral (sometimes possibly scalariform), gametangia enlarged; immature zygospores globose, 48–72 µm long, 75–78 µm in diameter (from the specimen at BRI).

Taxonomic Assessment: *Spirogyra nitida* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 90–300 µm long, (60–)70–90(–110) µm in diameter, with plane end-walls; chloroplasts 3–5, making 0.5–1.5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia, vegetative cells of conjugating filaments not swollen, gametangia cylindrical or enlarged; zygospores ellipsoid or slightly ovoid, (73–)90–177 µm long, (50–)60–89 µm in diameter, middle wall thick, smooth and brown. Cell dimensions vary slightly between Moebius's (1895) report and this description, but the illustrations showing the sometimes attenuated spores are a good match. Moebius (1895; translated in Bailey 1895, 34) notes the specimen matches the diagnosis of *S. nitida* but 'the spores are not yellowish (flavescentes) but chestnut-brown'. The description by McLeod (1975) is also consistent with *S. nitida* as described here. The herbarium material examined, however, has too few chloroplasts along with lateral conjugation. In the absence of mature spores it cannot be identified to species. The other reports lack documentation and also cannot be verified.

30. Spirogyra porticalis (O.F. Müll.) Cleve, *Nova Acta Regiae Soc. Sci. 7 Upsal.* Ser. 3, 6: 22, pl. 5 fig. 8-9 (1868). *Conferva porticalis* O.F. Müll., *Nova Acta Acad. Sci. Imp. Petrop. Hist. Acad.* pars 3: 90 (1785); *Zygnema porticalis sensu* Watts, *Victorian Naturalist* 1: 21 (1884); *Zygnema quininum* C. Agardh, *Syst. Alg.* 80 (1824).

Known Distribution: North and South America, Europe, North Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Lake Broadwater, *J.A. Grimes*, xi.1986 (Grimes 1988); Freestone, Warwick, [s. d.](Pigram 1909); Bell and Walsh River, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917). VICTORIA: swamp at Ballarat (Watts 1865, as '*Zygnema guininum* '[presumably misspelt *Z. quininum*]; Yan Yean Reservoir, *G.S. West*, x.1905 (Hardy 1906; West 1909).

Description of Australian Specimens: Vegetative cells 3 times as long as broad, end-walls plane; chloroplast single, making 3–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia slightly swollen; zygospores ovoid, outer wall smooth, middle wall smooth. (calculated from illustration in Pigram 1909).

Taxonomic Assessment: *Spirogyra porticalis* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992) by vegetative cells 66–200 µm long, 40–55 µm in diameter, with plane end-walls; chloroplast single, making 2.5–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; vegetative cells of conjugating filament not swollen, gametangia cylindrical or slightly enlarged; zygospores mostly ovoid to globose-ovoid, (42–)50–83 µm long, (33–)35–54 µm in diameter, middle wall smooth and yellow. Pigram (1909) was unsure as to whether his collection should be referred to *S. quinina* Kütz. or *S. porticalis*. De Toni (1889) and Borge (1913) consider both names to be synonymous (*S. porticalis* the earlier of the two) while later authors have kept the taxa apart. In any case, Pigram's (1909) description is concordant with the above description of *S. porticalis*. The illustration in Grimes (1988) matches the illustrations published elsewhere with the exception of the zygospore being slightly ovoid or even acuminate at one end. Despite published descriptions stating that the zygospores are ovoid only those Kargupta and Sarma (1992) show any zygospores of this shape. Nevertheless, the collection by Grimes is accepted as *S. porticalis* as is the McLeod (1975) collection. There is not enough information to confidently identify the other Australian collections (including Watts's undocumented report of *S. quinina* which is referred here).

31. Spirogyra protecta H.C. Wood, *Contr. Freshwat. Alg. N. Amer.* 19: 165, t. 14 fig. 3 (1872). *Spirogyra calospora* Czurda, *Süsswasserflora* 9: 147 (1932).

Known Distribution: North America, Europe, Africa, Australia.

Specimens Reported: QUEENSLAND: Caboolture River, *T.L. Bancroft*, v.1893 (Moebius 1892; Bailey 1893, 1913; Pigram 1909; all as *S. calospora*).

Description of Australian Specimens: Vegetative cells c. 27 µm in diameter, 5–8 times as long as broad, end-walls replicate; chloroplasts making 4–5 turns; gametangia somewhat turgid, shorter than vegetative cells; zygospores elliptical, 64–70 µm long, 30–36 µm in diameter, middle wall brown, scrobiculate, in optical section appearing streaked with fine striations.

Taxonomic Assessment: *Spirogyra protecta* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 120–425 µm long, 27–42 µm in diameter, with end-walls replicate; chloroplasts 1(–2), making 2–7 turns; conjugation scalariform,

conjugation tubes formed equally by both gametangia, gametangia cylindrical or enlarged; zygospores ellipsoid to cylindrical-ellipsoid, 66–90 µm long, 30–38(–50) µm in diameter, outer wall of 2 layers of which the inner is thick and scrobiculate the outer smooth and colourless, middle wall yellow, smooth; aplanospores similar to zygospores but smaller. Although the descriptions of *S. protecta* seem to vary between authors, the Australian collection fits within their combined ranges and the name is accepted in our census.

32. Spirogyra punctata Cleve var. **tenuior** Moebius, *Flora* 75: 438 (1892).

Known Distribution: Australia.

Specimen Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Bailey 1893, 1913; Moebius 1892).

Description of Australian Specimens: Vegetative cells 18–20 µm in diameter, 3–5(–8) times as long as broad, chloroplast single, making 3–5 turns; conjugation tubes formed by the male gametangia; zygospores 60–70 µm long, 33–32 µm in diameter, middle wall punctate.

Taxonomic Assessment: *Spirogyra punctata* is described by Borge (1913), Dillard (1990), Gauthier-Liévre (1965), Kadłubowska (1984) and Randhawa (1959). *Spirogyra punctata* thus far known only from the type collection, differs from the taxon described in these publications (and presumably characterizing the typical variety) by smaller vegetative cells and zygospore dimensions.

33. Spirogyra rivularis (Hassall) Rabenh., *Fl. Eur. Alg.* 3: 243 (1868). *Zygnema rivulare* Hassall, *Ann. Mag. Nat. Hist.* 10: 38 (1842).

Known Distribution: North America, Europe, South Africa, Asia, Papua New Guinea, Australia.

Specimens Reported: QUEENSLAND: Burpengary, *T.L. Bancroft*, iii.1893 (Bailey 1895, 1913; Moebius 1895); [s. loc] *F. Pigram*, [s. d.] (Pigram 1909); Toorbul Point and King John Creek, *J.A. McLeod*, [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells 30–38 µm in diameter, 4–15 times as long as broad, end-walls plane; chloroplasts 2, making 0–4 turns, conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia 2–3 times as long as broad, not inflated; zygospores elliptical to ovoid, 50–65 µm long, 20–34 µm in diameter.

Taxonomic Assessment: *Spirogyra rivularis* var. *rivularis* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 100–400 µm long, 36–41 µm in diameter, with plane end-walls; chloroplasts 2–3, making 2.5–3.5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia shortened, cylindrical or enlarged; zygospores ellipsoid, 60–100 µm long, 35–42 µm in diameter, middle wall smooth and yellow or brownish-yellow. Moebius (1895, 335) notes that 'the dimensions here specified do not agree in all respects with those of the typical species' and suggested that it could be var. *minor* Hansg. According to De Toni (1889), *S. rivularis* var. *minor* Hansg. has vegetative cells 24–0 µm in diameter and 3 times as long. Some Australian collections do not fall comfortably within either variety, but all Australian reports are accepted as *S. rivularis*. This species cannot be distinguished from *S. decimina* in the vegetative condition.

34. Spirogyra singularis Nordst., *Bot. Not.* 118 (1880). *Spirogyra silvicola* M.E. Britton, *Amer. J. Bot.* 30: 799, fig. 1 (1943).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Examined: QUEENSLAND: Sandgate Lagoon and Ashgrove Creek, *J.A. McLeod*, [s. d.] (McLeod 1975). SOUTH AUSTRALIA: Dickerees Lagoon, Birdsville Track, *J.W. Cribb*, 23.viii.1978 (BRI; Cribb 1983 as *S. silvicola*).

Description of Australian Specimens: Vegetative cells 105–110 µm long, c. 39 µm in diameter, end-walls plane; chloroplast single; conjugation tubes formed equally by both gametangia; gametangia cylindrical; zygospores elongate-ellipsoid, 55–90(–126) µm long, 33–42 µm in diameter, middle wall yellow-brown with green.

Taxonomic Assessment: Transeau (1951, 151) noted that the vegetative filaments of *S. silvicola* are 'similar to those of *S. singularis*' but the zygospores are larger. More recently, Dillard (1990) and Kadłubowska (1972, 1984) considered *S. silvicola* to be a synonym of *S. singularis*. *Spirogyra singularis* is characterized (Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 60–240 µm long, 29–42 µm in diameter, with plane end-walls; chloroplast single, making 3–7 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia not swollen; zygospores ellipsoid, 46–103 µm long, 27–43 µm in diameter, middle wall thickened, smooth and yellow or brown. The spores examined from the Australian material were elongate, matching the illustrations of *S. silvicola* in Transeau (1951), and all other features are consistent with the above description. The description provided by McLeod (1975) is also consistent with this data. The name *S. singularis* is therefore accepted for Australia. This species is similar to *S. longata*.

35. Spirogyra submaxima Transeau, *Amer. J. Bot.* 1: 295, pl. 27 figs 3-4 (1914).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: NEW SOUTH WALES: Gwydir River, Bundarra, *Schneider*, iii.1974 (Skinner 1980); Aberfoyle River, *S. Skinner*, iii.1974 (Skinner 1980); Falconers Creek, Guyra, *S. Skinner*, xii.1974 (Skinner 1980); Mother of Ducks Lagoon, Guyra, *S. Skinner*, xii.1974 (Skinner 1980). VICTORIA: Yarra River basin, *T.J. Entwisle 1316*, 2.vii.1987 (Entwisle 1989).

Description of Australian Specimens: Vegetative cells 110–280 µm long, 68–120 µm in diameter, end-walls plane; chloroplasts 7–10, making 1–2 turns; conjugation scalariform (involving entire filament), conjugation tubes formed equally by both gametangia; gametangia inflated; zygospores lenticular to slightly ovoid lenticular (56–)72–115 µm in diameter, 52–55 µm thick, middle wall smooth and golden-brown.

Taxonomic Assessment: *Spirogyra submaxima* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kad-lubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992; Habib 1993) by vegetative cells 100–300 µm long, 70–110 µm in diameter, with plane end-walls; chloroplasts 8–9, making 0.1–1 turn; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical, or inflated; zygospores and aplanospores lenticular, (58–)70–110 µm long, 50–75µm in diameter, middle wall smooth and brown. The Australian reports all match this description and the name *S. submaxima* is accepted for Australia.

36. Spirogyra tenuissima (Hassall) Kütz., *Sp. alg.* 437 (1849). *Zygnema tenuissimum* Hassall, *Hist. Brit. Freshwater Alg.* 152, pl. 32 fig. 9, 10 (1845).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: [s. loc.] *F. Pigram* [s. d.] (Pigram 1909); Ithaca, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: Yarra Glen, *A.D. Hardy*, 1906 (Hardy 1906).

Description of Australian Specimens: Vegetative cells 6–8 times as long as broad, end-walls replicate; conjugation scalariform and lateral; gametangia inflated; zygospores elliptical, (calculated from illustration in Pigram 1909).

Taxonomic Assessment: *Spirogyra tenuissima* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 40–250 μm long, 8–15 μm in diameter, with replicate end-walls; chloroplast single, making 3–6 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia greatly inflated or enlarged toward the middle; zygospores and aplanospores ellipsoid, 40–74 μm long, 22–36 μm in diameter, middle wall smooth and yellow. The illustration in Pigram (1909) matches published descriptions of *S. tenuissima* but without filament and zygospore dimensions the collections could also be *S. inflata, S. rugosa* or *S. discreta.* Hardy (1906) provides no documentation for his record. The description in McLeod (1975), however, matches closely *S. tenuissima* and this record is accepted.

37. Spirogyra teodoresci Transeau, *Ohio J. Sci.* 34: 420 (1934). *Spirogyra varians* var. *minor* Teodor., *Beih. Bot. Centralbl.* 21, abt. 2 (1907).

Known Distribution: North and South America, Europe, Asia, Australia.

Specimen Examined: QUEENSLAND: Running Creek, *A.B. Cribb 1185.6*, 30.iii.1991 (BRI; Cribb 1991).

Description of Australian Specimens: Filaments attached by rhizoidal extension of basal cell; vegetative cells 20–90 μm long, 27.5–35 μm diameter, 0.5–2.2 times as long as broad, end-walls plane; chloroplast making single, 1.5–4 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia inflated on conjugating side only or sometimes slightly also on opposite side; zygospores ellipsoid mostly with long axis parallel to long axis of filament (only oblique or transverse in relatively short gametangia), 37–55 μm long, 25–35 μm diameter, 1.4–1.7 times as long as broad, middle wall smooth and yellow-brown.

Taxonomic Assessment: *Spirogyra teodoresci* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 42–90 μm long, 24–30 μm in diameter, with plane end-walls; chloroplast single, making 1–6 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia strongly inflated on the conjugating side; zygospores ellipsoid, 45–55 μm long, 26–33 μm in diameter, middle wall smooth and yellow. The Australian report matches closely this description. Although also very similar to *S. varians*, the Cribb collection is slightly smaller in most features, and is therefore retained under the name *S. teodoresci.*

38. Spirogyra transeauiana C.C. Jao, *Sinensia* 6: 610, pl. 10 fig. 107 (1935).

Known Distribution: Asia, Australia.

Specimen Examined: SOUTH AUSTRALIA: Noarlunga Ford, Onkaparinka River, *D.P. Thomas and S. Skinner*, 14.x.1977.

Description of Australian Specimens: Vegetative cells 25–40 μm in diameter, end-walls replicate; chloroplasts 1–2, making about 4 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia enlarged on the conjugating side; zygospores ellipsoid, c. 100 μm long, 50–55 μm in diameter, green-gold to golden-brown.

Taxonomic Assessment: *Spirogyra transeauiana* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984) by vegetative cells 160–304 μm long, 42–61 μm in diameter, with replicate end-walls; chloroplasts 2–3, making 2–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical or slightly enlarged on the conjugating side; zygospores

ellipsoid with rounded ends, 96–138 µm long, 41–58 µm in diameter, middle wall smooth and yellow. Although the Australian material has thinner vegetative filaments than generally reported for *S. transeauiana* it matches this species more closely than any other species.

39. Spirogyra varians (Hassall) Kütz., *Sp. alg.* 439 (1849). *Zygnema varians* Hassall, *Hist. Brit. Freshwater Alg.* 145, pl. 29 figs 1-4 (1845).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Bardon and Mt. Alford, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: Yarra River Basin, *T.J. Entwisle 1048, 1034, 1347*, 2.vii.1987 (Entwisle 1989, 1990).

Description of Australian Specimens: Filaments sometimes attached by rhizoidal extensions; vegetative cells 16–72 µm long, 32–45 µm in diameter, 0.5–2.0 times as long as broad, sometimes swollen end-walls plane; chloroplast single; conjugation scalariform, conjugation tubes formed equally by both gametangia; female gametangia usually inflated on conjugating side; zygospores ellipsoid, 44–52 µm long, 28–32 µm in diameter, 1.2–1.8 times as long as broad, middle wall smooth and yellow.

Taxonomic Assessment: *Spirogyra varians* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 30–120 µm long, 29–40 µm in diameter, with plane end-walls; chloroplast single, making 1–5 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia usually inflated on the conjugating side only, rarely on both sides, some of the sterile cells usually inflated, zygospores mostly ellipsoid, usually some of them ovoid and very rarely globose, (36–)50–100 µm long, (24–)32–40 µm in diameter, middle wall smooth and yellow; aplanospores similar to the zygospores. The Victorian collection differs in only minor ways from this description and this record is accepted. The description in McLeod (1975) matches closely *S. varians* and is clearly based on her own description and observations. This species is similar to *S. teodoresci*.

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Vegetative cells with stellate or disc-shaped chloroplasts; zygote separated from gametangia by special walls; gametangia not filled with pectic cellulose-colloid and without cytoplasmic residues.

40. Zygnema binuclearioides Cribb, *Queensland Naturalist* 21: 8 (1974).

Specimens Reported: QUEENSLAND: Lake Birrabeen, Fraser Island, *A.B. Cribb*, 15.viii.1971 (Cribb 1974); Peregian and Coolum, *J.A. McLeod*, [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells (22–)25–32(–35) µm in diameter, end-walls up to 120 µm thick; chloroplasts sometimes with 2 pyrenoids (in one or both chloroplasts); gametangia somewhat inflated; zygospores ellipsoid to cylindrical-ellipsoid, (17–)20–40(–42) µm long, (17–)20–25(–30) µm diameter, (1–)1.3–1.7(–1.9) times as long as broad; akinetes ellipsoid to cymbiform-ellipsoid.

Taxonomic Assessment: *Zygnema binuclearioides* is known from the type collection and two other collections by McLeod (1975). However, the description by McLeod seems to be taken from the protologue and only the type collection is accepted here as representing the species. *Zygnema binuclearioides* is accepted in Australia and is included in our census. It resembles the genus *Binuclearia* Wittr in vegetative morphology.

41. Zygnema carterae Czurda, *Süsswasserflora* 9: 114 (1932).

Known Distribution: New Caledonia, Australia.

Specimen Reported: SOUTH AUSTRALIA: Hacks Lagoon Cons. Pk, *L. Lloyd*, 15.ix.1982 (Skinner 1983).

Description of Australian Specimens: Vegetative cells (10–)12–16(–18) µm in diameter, 6–10(–12) times as long as broad, end-walls lenticular; conjugation scalariform; conjugation tube incomplete, zygospores held in mucilage between gametangial cells; zygospores spherical, 26–30 µm in diameter, middle wall scrobiculate, pale golden.

Taxonomic Assessment: *Zygnema carterae* is characterized (Czurda 1932; Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984) by vegetative cells (48–)64–128 µm long, 13–16 µm in diameter; conjugation lateral or scalariform; zygospores formed in the conjugating tubes, globose, 30–35 µm in diameter, middle wall scrobiculate and brown. No published illustrations of *Z. carterae* were found and Skinner (1983) states that his collection does not key out perfectly. According to Skinner (*in sched.*, AD *53989*) it 'differed from the type description ... in having only scalariform conjugation and a "halo" of mucilage rather than a closed gametangial tube.' Nevertheless, it matches *Z. carterae* more closely than any other published species.

42. Zygnema coeruleum Czurda, *Süsswasserflora* 9: 107, fig. 107 (1932).

Known Distribution: North America, Europe, South Africa, India, Australia.

Specimen Reported: NEW SOUTH WALES: Major Creek, Howell near Tinga, *Garrard*, vii.1974 (Skinner 1980).

Specimen Examined: QUEENSLAND: Jardine River, Cape York Peninsula, *A.B. Cribb 1038.12*, 27.viii.1985 (BRI; Cribb 1987).

Description of Australian Specimens: Vegetative cells 18–25 µm diameter, 3–4 times as long as broad, end-walls plane; conjugation scalariform; zygospores in conjugation tube, bulging into gametangia, globose to ellipsoid, 30–42.5 µm in diameter, 1–1.3 times as long as broad, middle wall yellow-brown to slate blue, 2–3 µm thick, lamellate, its outer part scrobiculate, with pits 1.5–2 µm diameter, 2–3 µm apart.

Taxonomic Assessment: *Zygnema coeruleum* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 40–55 µm long, (20–)24–26 µm in diameter; chloroplasts with rounded conspicuous pyrenoids; conjugation scalariform; zygospores formed in the conjugating tubes, ovoid to globose, 32–35 µm long, 26–32 µm in diameter, middle wall thick, scrobiculate and blue, pits c. 1.5 µm in diameter, c.3 µm apart. The Australian collections match closely this description and the name *Z. coeruleum* is accepted for Australia.

43. Zygnema cruciatum (Vaucher) C. Agardh, *Syn. Alg. Scand.* 102 (1817).

Conjugata cruciata Vaucher, *Hist. Conferv. Eau Douce* p. 76, fig. 2 (1803); *Tyndaridea cruciata* (Vaucher) Hassall, *Hist. Brit. Freshwater Alg.* 160, t. 38 fig. 1 (1845); *Zygnema dillwynii* Kütz., *Tab. Phycol.* 5: t. 17 (1855).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Ipswich, *J.A. McLeod*, [s. d.] (McLeod 1975). SOUTH AUSTRALIA: [s. loc., s. d.] (Sonder 1881; as *Z. dillwynii*). QUEENSLAND: Dalby, Darling Downs, *T.L. Bancroft*, v.1893 (Moebius 1895, Bailey 1895, 1913). NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917). VICTORIA: Meredith, ?*Kützing*, 1882 (Kützing 1882b). TASMANIA: South Esk River, *Gunn*, 1860 (Harvey 1860, as *Tyndaridea cruciata*; Sonder 1881).

Specimen Examined: QUEENSLAND: Dry Creek, Kroombit Tops, *A.B. Cribb 990.1*, 14.xii.1983 (BRI; Cribb 1986).

Description of Australian Specimens: Vegetative cells 15–38 µm long, 30–40 µm in diameter; receptive gametangia somewhat or not enlarged on the conjugating side; zygospores spherical, 28–32 µm long, 28–35 µm in diameter, almost filling the cell, middle wall scrobiculate and yellow-brown, with pits 1.5–3 µm diameter, 1 µm apart to almost continuous.

Taxonomic Assessment: *Zygnema cruciatum* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 30–60 µm long, 30–39 µm in diameter; conjugation scalariform; gametangia cylindrical or enlarged; zygospores in one of the gametangia, globose to ovoid, 32–40 µm long, 30–38 µm in diameter, middle wall scrobiculate and brown, pits 1.5–2 µm in diameter, 3–5 µm apart; aplanospores cylindrical-ovoid, 30–60 µm long, 30–35 in diameter, filling the vegetative cells, otherwise similar to the zygospores. The Cribb collection matches this description in most respects except, as Cribb (1986) noted, the pits in the middle wall are more similar to *Z. calosporum*. That species, however, has smaller vegetative cells and *Z. cruciatum* seems more appropriate. The description in McLeod (1975) matches closely *Z. cruciatum* but we cannot be sure of its source. Without further documentation, the earlier reports (Bailey 1895, 1913; Harvey 1860; Kützing 1882b; Moebius 1895; Playfair 1917; Sonder 1881) cannot be assessed.

44. Zygnema insigne (Hassall) Kütz., *Sp. alg.* 444 (1849). *Conjugata insigne* Hassall, *Hist. Brit. Freshwater Alg.* 440, t. 103 figs 1–2 (1845).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: Port Curtis district, *T.L. Bancroft*, v–vi.1892 (Moebius 1895; Bailey 1895, 1913). VICTORIA: Box Hill, *A.D. Hardy*, 12.v.1906 (Hardy 1906); [s. loc.] (Watts 1887).

Description of Australian Specimens: Filaments with a thick gelatinous covering as thick as the filament proper, vegetative cells 27–28 µm in diameter, 1.5–2 times as long as broad; zygospores globular, 27–30 µm in diameter.

Taxonomic Assessment: *Zygnema insigne* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 26–60 µm long, 26–32 µm in diameter; conjugation scalariform or lateral; female gametangia slightly, if at all, swollen; zygospores globose or subglobose, 27–35 µm long, 26–33 µm in diameter, middle wall thickened, smooth and yellow-brown; aplanospores 28–33 µm, ovoid to cylindrical-ovoid, otherwise similar to zygotes. The Queensland report matches this description and the name *Z. insigne* is accepted for Australia. The Victorian records cannot be confirmed as they include no documentation.

45. Zygnema melanosporum Lagerh., *Bot. Zentralbl.* 18: 279 (1884).

Known Distribution: North America, Europe, North Africa, India, Australia.

Specimen Reported: QUEENSLAND: Stanthorpe district, Girraween National Park and Bald Rock Creek, *A.B. Cribb*, 1-4.iv.1994 (Cribb 1994).

Description of Australian Specimens: Vegetative cells (30–)50–106 µm long, 22–27 µm in diameter, 1.3–4.5 times as long as broad; conjugation scalariform, female gametangia not or only slightly enlarged; zygospores globose, ellipsoid, ovoid or cylindrical-ellipsoid, 26–40 µm long, 20–35 µm in diameter, 1–1.6 (–2) times as long as broad, middle wall blue-black, with fine pits approximately 1 µm in diameter, 3–4 µm apart.

Taxonomic Assessment: *Zygnema melanosporum* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965) by vegetative cells 36–100 μm long, 22–27 μm in diameter; conjugation scalariform; female gametangia cylindrical or slightly enlarged; zygospores ovoid to cylindrical-ovoid, 28–36 μm long, 23–30 μm in diameter, middle wall finely punctate and dark blue. Although Cribb (1994) notes that a voucher was deposited at Queensland Herbarium (BRI) it was not sent as part of our loan. In any case, the description by Cribb (1994) matches the description except for extending some ranges, and the name *Z. melanosporum* is accepted in Australia.

46. Zygnema oveidanum Transeau, *Trans. Amer. Microscop. Soc.* 53: 208, pl. 17 fig. 1 (1934).

Known Distribution: North America, Australia.

Specimen Examined: QUEENSLAND: Rainbow Creek, Blackdown Tableland, *A.B Cribb 800.1*, 2.ix.1974 (BRI; Cribb 1976).

Description of Australian Specimens: Vegetative cells 24–66.5 μm long, 7.5–11.5 μm in diameter; conjugation tube inflated; zygospores globose, 21–27 μm in diameter, middle wall golden.

Taxonomic Assessment: *Zygnema oveidanum* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells (32–)35–40(–68) μm long, 8–12 μm in diameter; conjugation scalariform; zygospores formed in the conjugating tubes, ovoid to globose, 15–30 μm long, 12–15 μm in diameter, middle wall punctate, colourless to yellow, with pits about 1 μm in diameter. The Australian collection is consistent with the description and *Z. oveidanum* is accepted in our census.

47. Zygnema pectinatum (Vaucher) C. Agardh, *Syn. Alg. Scand.* 102 (1817).

Conjugata pectinata Vaucher, *Hist. Conferv. Eau Douce* 77, fig. 4 (1803); *Zygogonium pectinatum* Kütz., *Sp. alg.* 447 (1849); *Tyndaridea lutescens* Hassall, *Hist. Brit. Freshwater Alg.* t. 38 fig. 4 (1845). Equated with *Zygnema pectinatum* by De Toni (1889).

Known Distribution: North and South America, Europe, Asia, New Zealand, Australia.

Specimens Reported: NORTHERN TERRITORY: Alligator River Region, Umbungbung Billabong, *H.U. Ling and P.A. Tyler*, 30.v.1979 (Ling and Tyler 1986). QUEENSLAND: University Lake, St Lucia and Sandgate Lagoon, Stradbroke Island, *J.A. McLeod*, [s. d.] (McLeod 1975); Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892; Bailey 1893, 1913). NEW SOUTH WALES: Lismore, swamp on Woodlawn Road, *G.I. Playfair*, 1914 (Playfair 1915, 1917). VICTORIA: swamp at Ballarat and Lake Wangoon at Warrnambool (Watts 1865, as *Tyndaridea lutescens*); [s. loc.] (Kützing 1882b, as *Zygogonium pectinatum*).

Description of Australian Specimens: Vegetative cells 42–70 μm long; 20–33 μm in diameter, constricted at the end-walls and swollen in the middle; zygospores formed in the tube, globose, 43–46 μm long, 33–37 μm in diameter, middle wall pitted and brown.

Taxonomic Assessment: *Zygnema pectinatum* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 25–120 μm long, 30–36 μm in diameter; conjugation scalariform, rarely lateral; zygospores formed in the conjugation tube, globose to ellipsoid, 40–70 μm long, 33–60 μm in diameter, middle wall scrobiculate and brown, pits about 2–4 μm in diameter; aplanospores ovoid or cylindrical, 30–60 μm long, 30–38 μm in diameter, wall similar to that of the zygospore. The non-Victorian collections match the current literature and can therefore be retained under the name *Z. pectinatum*. The Kützing (1882b) and Watts (1865) reports include no documentation and cannot be assessed.

48. Zygnema spontaneum Nordst., *Alg. Ag. Dulc. Sandvic.* 17, pl. 1 figs 23–4 (1878).

Known Distribution: Hawaii, North America, Africa, Asia, Australia.

Specimen Reported: VICTORIA: Yan Yean Reservoir, *G.S. West*, xi–xii.1905–i.1906 (West 1909).

Description of Australian Specimens: Vegetative cells 15–17 µm in diameter; conjugation scalariform, conjugation tubes very wide; female gametangia inflated; zygospores projecting into conjugation tubes, 29–34 µm in diameter; aplanospore c. 20 µm in diameter.

Taxonomic Assessment: *Zygnema spontaneum* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 28–90 µm long, 14–22 µm in diameter; conjugation scalariform, female gametangia only slightly, if at all, swollen on the conjugating side; zygospores globose (sometimes irregular), 21–36 µm long, 18–25 µm in diameter, extending into the conjugation tube, middle wall thickened, scrobiculate and yellow to yellow-brown, pits about 2 µm in diameter, 3–5 µm apart; aplanospores often produced, ovoid to cylindrical-ovoid, 18–23 µm long, 16–22 µm in diameter, otherwise as zygospore. Gauthier-Liévre (1965), Transeau (1951), Randhawa (1959) report reproduction by aplanospores only. Some of the descriptions are clearly based on the description of West (1909, 52) who noted that the 'zygospores exhibited a considerable degree of variation in form and position... [and] were of relatively greater diameter' than those observed from West Africa and Burma. The Australian material keys out to *Z. decussatum* in Randhawa (1959) and Transeau (1951) and is similar also to *Z. subtile*, *Z. tenue* and *Z. cylindricum*. However, it does match at least some monographic accounts of *Z. spontaneum* and this determination is accepted here.

ZYGOGONIUM Kütz.

Vegetative cells with cushion-shaped chloroplasts; zygospores in sporangia of 2 cup-like parts with a suture; cytoplasmic residue remaining in the gametangia

49. Zygogonium ericetorum Kütz., *Phycol. General.* 446 (1843). *Zygnema ericetorum* (Kütz.) Hansg., *Prodr. Algenfl. Böhmen* 155 (1886).

Known Distribution: America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892; Bailey 1893, 1913); Beerwah, *R.L. Specht*, 1979 (Specht 1979). VICTORIA: Haddon and Wimmera, *F. Mueller*, 1882 (Kützing 1882b); [s. loc.] (Sonder 1881). TASMANIA: [s. loc.] (Sonder 1881).

Specimens Examined: QUEENSLAND: Peregian, Toorbul Point, Pialba, Coomera Island, Elliot Heads, *J.A. McLeod*, [s. d.] (McLeod 1975); Bowen Creek, Hinchinbrook Island, *A.B. Cribb 894.37*, 25.viii.1979 (BRI); Tributary of Sanamere Lagoon, Cape York Peninsula, *A.B. Cribb 1043.4*, 3.ix.1985 (BRI; Cribb 1987); Jardine River, Cape York Peninsula, *A.B. Cribb 1044.1*, 4.ix.1985 (BRI; Cribb 1987); Mimosa Creek, Blackdown Tableland, *A.B. Cribb 804.1*, 11.ix.1974 (BRI; Cribb 1976); Rainbow Creek, Blackdown Tableland, *A.B. Cribb 800.14*, 2.ix.1974 (BRI; Cribb 1976); North branch of Mimosa Creek, Blackdown Tableland, *A.B. Cribb 802.7*, 4.ix.1974 (BRI; Cribb 1976); Under Rainbow Falls, Blackdown Tableland, *A.B. Cribb 800.17*, 2.ix.1974 (BRI; Cribb 1976); Jimna State Forest, *A.B. Cribb 793.6*, 16.xi.1974 (BRI); Cholmondeley Creek, Cape York Peninsula, *A.B. Cribb 1193.4*, 12.iii.1992 (BRI); Bertie Creek, Cape York Peninsula, *A.B. Cribb 1194.2*, 12.iii.1992 (BRI); Wyberba near Stanthorpe, *A.B. Cribb*, x.1968 (BRI). TASMANIA: Lake Dove, 13.xii.1973, *A.B. Cribb 773.1* [BRI *706049*].

Description of Australian Specimens: Vegetative cells 12–60 µm long, 15–45 µm in diameter, end-walls plane; conjugation rarely present, lateral; aplanospores, akinetes and zygospores oblong to globose, 30–54 µm long, 18–37 µm in diameter, middle wall smooth and pale yellow.

Taxonomic Assessment: *Zygogonium ericetorum* is characterized (Borge 1913 Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Devi and Panikkar 1992) by branched or unbranched filaments with vegetative cells 10–100 µm long, 12–33 µm in diameter, conjugation scalariform; zygospores with definite sporangia formed by the conjugating tubes and cut off by a wall from the adjoining gametangia, ovoid to ellipsoid, 15–40 µm long, 13–26 µm in diameter, middle wall thick, smooth and colourless to yellow-brown; aplanospores occupying only part of the cell, globose or ovoid, 15–40 µm long, 15–20 µm in diameter, middle wall smooth. Moebius (1892, 438) refers a collection with 'cells 18 µm thick, once to twice as long, at times with side sprays' to var. *terrestris* Kirchner. Almost all of the Australian specimens are sterile but the vegetative features are fairly distinctive and match the above description. The name *Z. ericetorum* is accepted in our census.

50. Zygogonium heydrichii (W. Schmidle) Transeau, *Ohio J. Sci.* 33: 159 (1933).

Zygnema heydrichii W. Schmidle, *Flora* 84: 167 (1897).

Known Distribution: Australia.

Specimen Reported: NEW SOUTH WALES: Quarantine Station in Sydney, *Lauterbach*, 1876 (Schmidle 1897).

Description of Australian Specimens: Vegetative cells 25–66 µm long, 14–20 µm in diameter, wall lamellate; conjugation lateral; zygospores formed in conjugating tube, ellipsoid, rarely globose or heart-shaped, c. 32 µm long, 24–28 µm in diameter, middle wall pitted and yellowish.

Taxonomic Assessment: Schmidle (1897) notes that the chloroplasts and other features were difficult to observe due to the poor quality of the material and he was unsure whether this species belonged to *Zygnema* or *Zygogonium*. The taxon is now referred to *Zygogonium*, and the name *Zygogonium heydrichii* is accepted here.

51. Zygogonium kumaoense Randhawa, *J. Indian Bot. Soc.* 19: 247 (1940).

Known Distribution: India, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Peregian, *J.A. McLeod*, [s. d.] (McLeod 1975); Lake Birrabeen, Fraser Island, *A.B. Cribb*, viii.1971 (Cribb 1974).

Specimens Examined: QUEENSLAND: 'Heathlands', Cape York Peninsula, *A.B. Cribb 1212.2*, 23.iii.1992 (BRI); Ramsay Bay, Hinchinbrook Island, *A.B. Cribb 829.13*, 12.viii.1975 (BRI); Jardine River, Cape York Peninsula, *A.B. Cribb 1044.4*, 4.ix.1985 (BRI; Cribb 1987).

Description of Australian Specimens: Attachment filaments branched, cells irregular; vegetative cells cylindrical, 30–82 µm long, 5–21 µm diameter, 4–24 µm as long as broad, rhizoidal outgrowths occasional, knob-like to irregular; aplanospores not or only slightly distending the filament, borne in any part of the cell but commonly at one end, sometimes at the end of a rhizoid, subglobose to ellipsoid, 8.5–12.5 µm long, 7.5–8.5 (15–22) µm diameter, middle wall hyaline, unornamented.

Taxonomic Assessment: *Zygogonium kumaoense* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1984; Devi and Panikkar 1992) by vegetative filaments with irregular cells, 20–140 µm long, 9.5–14 µm in diameter, with rhizoids; conjugation scalariform; zygospores globose, 25–29 µm in diameter, middle wall thick, smooth, yellow; aplanospores globose to subglobose,

15–24 µm long, 12–17 µm in diameter, middle wall smooth and transparent. There is some difference of opinion over whether lateral conjugation sometimes occurs or whether such reports are of misinterpreted aplanospores. The Australian collections have smaller 'aplanospores' than are reported generally for *Z. kumaoense* but seem to match this species in all other respects. The name is therefore accepted here.

Key to Accepted Taxa

This key is based, as far as possible, on data from Australian reports and collections. Where there are discrepancies between the Australian reports and world monographs we have only used the latter to avoid blatant contradictions.

1. Vegetative cells with elongate chloroplasts extending the length of the cell 2
1. Vegetative cells with stellate or disc-shaped chloroplasts 45

2. Cells with 1 axial chloroplast 3
2. Cells with 1-several parietal, spiral chloroplasts 10

3. Vegetative filaments < 8 µm in diameter; zygote not separated from gametangia by special walls; cytoplasmic residue not left in the gametangia; sporangia filled with pectic cellulose-colloid ....**1. *Debarya hardyi***
3. Vegetative filaments usually > 8 µm in diameter; zygotes separated from gametangia by special walls; cytoplasmic residue left in the gametangia 4

4. Zygospores H-shaped, middle wall lamellate ....**6. *Mougeotia sestertisignifera***
4. Zygospores not H-shaped, middle wall smooth 5

5. Conjugation tubes enlarged 6
5. Conjugation tubes not enlarged 8

6. Vegetative filaments diameter less than 20 µm ....**4. *Mougeotia parvula* var. *parvula***
6. Vegetative filaments diameter more than 20 µm 7

7. Vegetative filaments diameter 43–54 µm; zygospores 51–70 µm in diameter ....**2. *Mougeotia acadiana***
7. Vegetative filaments diameter 34–41 µm; zygospores 36–47(–60) in diameter ....**3. *Mougeotia laetevirens***

8. Sporangium surrounded by pectic material; zygospores less than 25 µm in diameter ....**8. *Mougeotia victoriensis***
8. Sporangium not surrounded by pectic material; zygospores more than 25 µm in diameter 9

9. Zygospores less than 40 µm in diameter ....**5. *Mougeotia scalaris***
9. Zygospores more than 40 µm in diameter ....**7. *Mougeotia subcrassa***

10. Vegetative filaments more than 70 µm in diameter 11
10. Vegetative filaments less than 70 µm in diameter 17

11. Chloroplasts spiraled more than 2 times ....**16. *Spirogyra ellipsospora***
11. Chloroplasts spiraled 2 or fewer times 12

12. Chloroplasts usually fewer than 6 per cell; vegetative filaments 60–80 µm in diameter 13
12. Chloroplasts usually more than 6 per cell; vegetative filaments 70–140 µm in diameter 14

13. Chloroplasts 5–6 per cell; zygospores 45–60 µm in diameter **11. *Spirogyra bellis***
13. Chloroplasts 3–5 per cell; zygospores 55–89 µm in diameter **29. *Spirogyra nitida***

14. Gametangia inflated ....**35. *Spirogyra submaxima***
14. Gametangia cylindrical 15

15. Vegetative filaments 108–130(–140) µm in diameter ....**25. *Spirogyra maxima***
15. Vegetative filaments 77–80(–118) µm in diameter ....**27. *Spirogyra moebii***

16. Vegetative filaments 66–200 µm long, 40–55 µm in diameter; zygospores 54–54 µm in diameter .... **30. *Spirogyra porticallis***
16. Combined characters not as above 17

17. Zygospores more than 40 µm in diameter 18
17. Zygospores less than 40 µm in diameter 26

18. Cell end-walls replicate 19
18. Cell end-walls plane 21

19. Gametangia enlarged on conjugation side only .... **38. *Spirogyra transeauiana***
19. Gametangia inflated or enlarged equally on both sides 20

20. Conjugation tubes formed equally by both gametangia .... **17. *Spirogyra farlowii***
20. Conjugation tubes formed largely by male gametangia .... **20. *Spirogyra grevilleana***

21. Vegetative cell less than 46 µm in diameter 22
21. Vegetative cell more than 46 µm in diameter 23

22. Conjugation scalariform and lateral .... **24. *Spirogyra longata***
22. Conjugation only scalariform .... **34. *Spirogyra singularis***

23. Gametangia cylindrical 24
23. Gametangia not cylindrical 25

24. Chloroplasts one per cell; zygospores 40–45 µm in diameter .... **9. *Spirogyra australiensis***
24. Chloroplasts 1–3 per cell; zygospores 42–70 µm in diameter .... **12. *Spirogyra columbiana***

25. Chloroplasts 5 or more per cell .... **11. *Spirogyra bellis***
25. Chloroplasts less than 5 per cell .... **28. *Spirogyra neglecta***

26. Cell end-walls replicate 27
26. Cell end-walls plane 33

27. Vegetative cells less than 23 µm in diameter 28
27. Vegetative cells more than 23 µm in diameter 31

28. Chloroplast spiraled 5–9 times per cell .... **19. *Spirogyra frigida***
28. Chloroplast spiraled 2.5–6 times per cell 29

29. Conjugation tubes formed by male gametangia .... **14. *Spirogyra cylindrica***
29. Conjugation tubes formed by both gametangia 30

30. Vegetative filaments more than 15 µm in diameter .... **21. *Spirogyra inflata***
30. Vegetative filaments less than 15 µm in diameter .... **36. *Spirogyra tenuissima***

31. Conjugation tubes formed largely by male gametangia. **20. *Spirogyra grevilleana***
31. Conjugation tubes formed equally by both gametangia 32

32. Middle wall not scrobiculate .... **17. *Spirogyra farlowii***
32. Middle wall scrobiculate .... **31. *Spirogyra protecta***

33. Chloroplasts more than 1 per cell 35
33. Chloroplasts 1 per cell 37

34. Vegetative cells less than 24 µm in diameter .... **10. *Spirogyra baileyi***
34. Vegetative cells more than 24 µm in diameter 35

35. Gametangia cylindrical; pyrenoids numerous .... **22. *Spirogyra irregularis***
35. Gametangia shortened, cylindrical or enlarged; pyrenoid few 36

36. Vegetative filaments 60–150 µm long; zygospores 31–68 µm long .... **15. *Spirogyra decimina***
36. Vegetative filaments 100–400 µm long; zygospores 50–100 µm long .... **33. *Spirogyra rivularis***

37. Conjugation tubes formed by the male gametangia; zygospores middle wall punctate .... **32.** ***Spirogyra punctata*** var. ***tenuior***
37. Conjugation tubes formed by both gametangia; zygospores middle wall not punctate 38

38. Gametangia cylindrical or occasionally slightly inflated 39
38. Gametangia always strongly inflated at least on one side 42

39. Zygospores about 18–26 µm in diameter .... **13.** ***Spirogyra communis***
39. Zygospores more than 26 µm in diameter 40

40. Conjugation only scalariform; zygospores 55–90(–126) µm long .... **34. Spirogyra** ***singularis***
40. Conjugation scalariform and lateral; zygospores less than 90 µm long 41

41. Zygospores always less than 3 times as long as broad .... **23.** ***Spirogyra juergensis***
41. Zygospores 3–4 times as long as broad .... **24.** ***Spirogyra longata***

42. Vegetative cells less than 21 µm in diameter .... **18.** ***Spirogyra fennica***
42. Vegetative cells more than 21 µm in diameter 43

43. Reproduction by aplanospores (rarely by scalariform conjugation) .... **26.** ***Spirogyra mirabilis***
43. Conjugation scalariform or lateral 44

44. Vegetative filaments 24–35 µm in diameter .... **37.** ***Spirogyra teodoresci***
44. Vegetative filaments 29–45 µm in diameter .... **39.** ***Spirogyra varians***

45. Chloroplasts cushion-shaped 46
45. Chloroplasts stellate 48

46. Reproduction by aplanospores only, spore wall transparent .... **51.** ***Zygogonium kumaoense***
46. Reproduction by zygospores (sometimes aplanospores), spore yellow 47

47. Middle wall of spores smooth .... **49.** ***Zygogonium ericetorum***
47. Middle wall of spores scrobiculate .... **50.** ***Zygogonium heydrichii***

48. Cell cross-walls stratified, vegetatively resembling *Binuclearia* .... **40.** ***Zygnema binuclearioides***
48. Cell cross-walls not thick or stratified 49

49. Middle walls of spores smooth .... **44.** ***Zygnema insigne***
49. Middle walls of spores scrobiculate 50

50. Middle walls of spores blue 51
50. Middle walls of spores not blue 52

51. Zygospores formed in conjugation tube .... **42.** ***Zygnema coeruleum***
51. Zygospores formed in one of the gametangia .... **45.** ***Zygnema melanosporum***

52. Vegetative filaments less than 20 µm in diameter 53
52. Vegetative filaments more than 20 µm in diameter 55

53. Vegetative filaments less than 12 µm in diameter .... **46.** ***Zygnema oveidanum***
53. Vegetative filaments more than 12 µm in diameter 54

54. Gametangia not inflated; zygospores formed entirely within conjugation tube .... **41.** ***Zygnema carterae***
54. Gametangia inflated on the conjugation side; zygospores formed in gametangia and extending partly into conjugation tube .... **48.** ***Zygnema spontaneum***

55. Zygospores less than 40 µm long .... **43.** ***Zygnema cruciatum***
55. Zygospores more than 40 µm long .... **47.** ***Zygnema pectinatum***

Rejected Taxa

The following names are excluded from the census. They were either reported without any supporting documentation or do not match protologues and monographic accounts; none are represented by adequate voucher material.

Mougeotia capucina (Bory) C. Agardh, *Syst. Alg.* 84 (1824). *Leda capucina* Bory, *Moug. et Nestl. Exs.* n. 793 [s. d.].

Known Distribution: Hawaii, North and South America, Europe, Central Africa, New Zealand.

Specimen Reported: TASMANIA: *C. Stuart*, 1852 (Sonder 1852, 1880).

Specimen Examined: NEW SOUTH WALES: Heathcote, Woronora River, *A.A. Hamilton and A.H.S. Lucas*, 4.x.1915 (NSW *398968*).

Description of Australian Specimens: Vegetative cells 39-160 μm long, 24–27 μm in diameter, end-walls plane.

Taxonomic Assessment: *Mougeotia capucina* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 70–280(–340) μm long, 14–21 μm in diameter, usually violet coloured, 1 or 2 chloroplasts either rod-shaped occupying one-third to one quarter of the cell with 4–8 pyrenoids, or ribbon-like occupying three-fourths of the cell with 12–16 pyrenoids in a single row; conjugation scalariform; sporangia dividing both gametangia; zygospores extending into the gametangial cell, irregularly quadrate with concave sides, 60–100 μm long, 45–70 μm in diameter, middle wall thick, smooth and violet to brown; aplanospores 45–70(–80) μm long, 20–36 μm in diameter. The Australian herbarium material has narrower filaments than reported generally for *M. capucina* and in the absence of fertile material this determination cannot be confirmed. The Sonder (1852, 1880) reports include no supporting documentation and are not vouchered.

Mougeotia decussata Kütz., *Phycol. Germ.* 222 (1845).

This species was reported by Kützing (1882b) from Ballarat, Victoria.

Mougeotia elegantula Wittr., *Gotl. Ölands Sötv.-alg.* 40 (1872).

This species was reported by Playfair (1917) from New South Wales.

Mougeotia genuflexa (Dillwyn) C. Agardh, *Syst. Alg.* 83 (1824). *Conferva genuflexa* Dillwyn, *Brit. Confev.* pl. 6: 51 (1809).

Known Distribution: North America, Europe, Africa, Asia.

Specimen Reported: QUEENSLAND: Lake Broadwater, *J.A. Grimes*, xi.1986 (Grimes 1988).

Description of Australian Specimens: Vegetative cells 150 μm long, 20 μm in diameter; conjugation lateral and scalariform; zygospores forming in the conjugation tube (calculated from illustration in Grimes 1988).

Taxonomic Assessment: *Mougeotia genuflexa* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 50–225 μm long, 25–40 μm in diameter, frequently geniculate and interconnected, thus forming extensive nets; conjugation usually lateral (sometimes scalariform with zygospores not extending into either gametangia); zygospores quadrately ovoid to globose, 30–40 μm in diameter, middle wall smooth and yellow-brown to brown. The dimensions and mode of conjugation illustrated by Grimes (1988) are consistent with the above published accounts of *M. genuflexa* but also match at least five other species. Without further information we prefer to reject this taxon from Australia.

Mougeotia gracillima (Hassall) Wittr., *Bih. Kongl. Svenska Vetensk.-Akad. Handl.* 1: 40 (1872). *Staurocarpus gracillimum* Hassall, *Ann. Nat. Hist.* 12: 185, pl. 7 fig. 6 (1843).

This species was reported by Hardy (1906) from Sandringham, Victoria.

Mougeotia laevis (Kütz.) W. Archer, *Quart. J. Microscop. Soc.* 6: 272; 7: pl. 8 figs 1–3 (1866). *Zygogonium laeve* Kütz., *Sp. alg.* 447 (1849); *Debarya laevis* (Kütz.) West & G.S. West, *J. Roy. Microscop. Soc. London* 476 (1897).

This species was reported by Playfair (1917, as *Debarya laevis*) from New South Wales.

Mougeotia nummuloides (Hassall) De Toni, *Syll. Alg.* 1: 713 (1889). *Mesocarpus nummuloides* Hassall, *Hist. Brit. Freshwater Alg.* 169, t. 45 fig. 1 (1845).

Known Distribution: North America, Europe, Africa.

Specimen Examined: QUEENSLAND: Nerang River, Ships Stern area, *A.B. Cribb 845.3*, 14.vi.1976 (BRI).

Description of Australian Specimens: Vegetative cells 18–36 µm in diameter, zygospores 33–51 µm in diameter, middle wall yellow-green.

Taxonomic Assessment: *Mougeotia nummuloides* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 32–160 µm long, 8–16 µm in diameter, chloroplasts with 2–6 pyrenoids in a row; conjugation scalariform (gametangia slightly bent); zygospores in the conjugating tubes, globose to ovoid (17–)22–23(–37) µm in diameter, middle wall brown, scrobiculate; aplanospores ovoid, within the angled sporogenous cell. The measurements taken from the Queensland specimen are substantially larger than those reported generally for *M. nummuloides*. As the specimen examined is so poorly preserved, it cannot be confidently identified.

Mougeotia oblongata Transeau, *Trans. Amer. Micros. Soc.* 53: 219, fig. 38 (1934).

Known Distribution: North America.

Specimen Reported: QUEENSLAND: Blunder, *J. Peberdy* [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells 72–110 µm long, 9–10.5 µm in diameter; chloroplasts with 6 pyrenoids in a row; conjugation scalariform; zygospores 16–18.5 µm long, c. 14 µm in diameter, formed in the conjugation tube, bilobate-ovoid, middle spore wall smooth and yellow.

Taxonomic Assessment: *Mougeotia oblongata* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 80–200 µm long, 14–22 µm in diameter; chloroplasts with 6–12(–16) pyrenoids in a row; conjugation scalariform, often connecting several filaments; zygospores usually bilobate-ovoid, sometimes more cylindrical with concave sides, 47–58 µm long, 28–36 µm in diameter, formed in the conjugation tube, middle wall yellow, sometimes finely punctate. The middle wall appeared smooth in the Queensland collection, and the dimensions of the zygospores and filaments are considerably smaller than those above. Although the characteristic zygospore shape and location match *M. oblongata*, the differences are too substantial to accept the record for Australia. It is possible that this record represents a new taxon.

Mougeotia parvula var. ***angusta*** (Hassall) Kirchn. in Cohn, *Krypt.-Fl. Schlesein* 128 (1878). *Mesocarpus angustus* Hassall, *Hist. Brit. Freshwater Alg.* 170, pl. 45 fig. 4 (1845).

This variety was reported by West (1909) from Yan Yean Reservoir, Victoria.

Mougeotia poinciana Transeau, *Trans. Amer. Microscop. Soc.* 53: 224 (1934).
Known Distribution: North America.
Specimen Reported: NORTHERN TERRITORY: Alligator River Region, Coonjimba Billabong, *H.U. Ling and P.A. Tyler*, 13.v.1978 (Ling and Tyler 1986).
Description of Australian Specimens: Vegetative cells 170–200 µm long; 15–17 µm in diameter; zygospores c. 42 µm in diameter.
Taxonomic Assessment: *Mougeotia poinciana* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1984; Dillard 1990) by vegetative cells 100–200 µm long, 21–25 µm in diameter, chloroplasts with 6–10 pyrenoids in a single series; conjugation scalariform; gametangia bent; zygospores mostly within the female gametangium, sometimes extending somewhat into the conjugation tube, triangular-ovoid to globose, 35–51 µm long, 36–44 µm in diameter, (sporangium dividing one of the gametangia), middle wall smooth and yellow; aplanospores obliquely ovoid, 32–48 µm long, 24–30 µm in diameter. The zygospore diameter and reproductive morphology illustrated by Ling and Tyler (1986) match other published accounts, but the cell dimensions are contrary. *Mougeotia floridana*, in the same section (*Plagiospermum*) as *M. poinciana*, has filaments 14–20 µm in diameter (Dillard 1990), similar to those of the Australian record. In addition, the illustrations of *M. floridana* in Transeau (1951) and Bourrelly (1990) match the Australian illustration. However, according to Kadłubowska (1984), *M. floridana* has globose to tri-lobed zygospores located within the female gametangium (only rarely slightly extending into the conjugation tube) features not obvious in the Australian illustration. Transeau (1951) states that the zygospores in *M. floridana* occupy the middle of the receptive gametangia and the tubes, a feature also not present in the Australian material. On reproductive morphology the name *M. floridana* is inapplicable, and the vegetative differences between the Northern Territory collection and *M. poinciana* are substantial , so we reject this name too pending further study. It is possible that this record represents a new taxon.

Mougeotia recurva (Hassall) De Toni, *Syll. Alg.* 1: 714 (1889). *Mesocarpus recurvus* Hassall, *Hist. Brit. Freshwater Alg.* 168 (1845).
Known Distribution: Canada, North and South America, Europe, India.
Specimen Reported: VICTORIA: Yan Yean Reservoir, *G.S. West*, xi.1905 (West 1909).
Specimen Examined: QUEENSLAND: Stream on Mt Coot-tha, *A.B. Cribb 968.3*, 21.iv.1983 (BRI).
Description of Australian Specimens: Vegetative cells 12–14 µm diameter, zygospores 25–28 µm diameter; aplanospores globular and cylindrical, 34 µm long, 14–24 µm in diameter (from West 1909). Vegetative cells 80–140 µm long, 18–30 µm in diameter, with 3–6 pyrenoids; no fertile material seen (*A.B. Cribb 968.3*, BRI).
Taxonomic Assessment: *Mougeotia recurva* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 50–180 µm long, (10–)12–18 µm in diameter, chloroplast with 4–8 pyrenoids in a single series; conjugation scalariform; gametangia only slightly bent; zygospores globose, 22–33 µm in diameter, wholly within the conjugation tube, middle wall smooth and brown; aplanospores globose, 24–30 µm in diameter at bends in geniculate cells or cylindrical-ovoid, 28–34 µm long , 14–18 µm in diameter in straight cells. West (1909, 50) observed only a few individuals and suggested 'they differed [from one another] in the proportionately longer vegetative cells and in the straightness of the conjugating cells. The specimens observed were probably abnormal states, as some of the filaments had produced both globular and cylindrical aplanospores, the former (diameter 24 µm at the outer angles of geniculate cells, and the latter (long. 34 µm; lat. 14 µm) in the middle of straight

cells.' West (1909) was uncertain about the determination of this species. The measurements by West match those reported generally for *M. recurva*, but due to West's own uncertainty and the lack of additional material, a definite identification can not be made. The Queensland material had broader filaments than generally reported for this species, and without fertile material, it too can not be confidently identified.

Mougeotia violacea Kütz., *nom. nud.* (Day *et al.* 1995).
This species was reported by Kützing (1882b) from Ballarat, Victoria.

Mougeotia viridis (Kütz.) Wittr., *Bih. Kongl. Svenska Vetensk.-Akad. Handl.* 1: 39 (1872).
Staurospermum viridis Kütz., *Phycol. General.* 278 (1843).
This species was reported by May (1972) from Braidwood, New South Wales; Nobel & Happey-Wood (1987) from central southern New South Wales; and West (1909) from Yan Yean Reservoir, Victoria.

Sirogonium sticticum (Sm.) Kütz., *Phycol. General.* 278 (1843).
Conferva stictica Sm., *Eng. Bot.* 35: t. 2463 (1813); *Spirogyra stictica* (Sm.) Wille *Bihang Till K. Sv. Vet.-Akad. Handlingar* 8(18): 34 (1884).
Known Distribution: Asia, Africa, Europe, South and North America.
Specimens Reported: QUEENSLAND: Herston Road, Brisbane, *W.J. Bryam*, 1898 (Schmidle 1896, Bailey 1898; 1913), Ashgrove, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Aberfoyle River, *S. Skinner*, iii, vii-x.1974 (Skinner 1980); Falconers Creek, *S. Skinner*, xii.1974 (Skinner 1980); Little Guyra Lagoon, *S. Skinner*, xii.1974 (Skinner 1980); Cooney Creek, near Hillgrove, *S. Skinner*, xii.1974 (Skinner 1980). VICTORIA: Hatherley, *J. Stickland*, 1897 (Stickland 1897).
Description of Australian Specimens: Vegetative cells 130–160 µm long, 60–65 µm in diameter; zygospores 65–70 µm in diameter.
Taxonomic Assessment: *Sirogonium sticticum* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Dillard 1990) by vegetative cells, 80–300 µm long, 38–56 µm in diameter; 3–6 chloroplasts, nearly straight or making 0.5 turn; conjugation directly between usually shortened and somewhat reflexed gametangia; zygospores ellipsoid or ovoid (66–)68–127 micrometres long, 40–67(–90) µm in diameter, middle wall smooth, yellow, often with a distinct fissure line. The New South Wales records are described by slightly larger filaments than reported elsewhere in the literature and no fissure line was noted on the zygospores. The description given by Skinner (1980) seems closer to that of *S. floridanum* (references cited above). As there are no descriptions or illustrations of the remaining Australian specimens, we reject this name pending further evidence. Without details about chloroplast and reproductive morphology we cannot confirm that the genus *Sirogonium* occurs in Australia.

Spirogyra alpinum Kütz., *Sp. alg.* 439 (1849). ?'*Zygogonium alpinum* Kütz.'
This species was reported by Sonder (1880, 1881; both as '*Zygogonium alpinum*') from Victoria.

Spirogyra catenaeformis (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema catenaeformis* Hassall, *Ann. Nat. Hist.* 10: 39 (1842).
This species was reported by Skinner (1989; as '*S.* sp. aff. *S. catenaeformis*') from Dalhousie Springs.

Spirogyra condensata (Vaucher) Kütz., *Phycol. General.* 279, t. 5, fig. 2 (1843).
Conjugata condensata Vaucher, *Hist. Conferv. Eau Douce* 67, pl. 5 fig. 2 (1803).
This species was reported by Hardy (1906) from Berwick, Victoria, and Watts (1887) from Victoria.

Spirogyra crassa (Kütz.) Kütz., *Phycol. General.* 280, pl. 14 fig. 4 (1843).
Zygnema crassum Kütz., *Alg. Aq. Dulc. Germ.* No. 98 (1834).
Known Distribution: North America, Europe, South Africa, India, New Zealand.
Specimens Reported: QUEENSLAND: Port Curtis District, *M. Moebius*, v–vi.1893 (Moebius 1895; Bailey 1895, 1913; Pigram 1909); University Lake, St Lucia, Schultz's Clayfield, Indooroopilly, Upper Brookfield, [s. d.] (McLeod 1975). NEW SOUTH WALES: Lismore, Wyrallah Road, *G.I. Playfair*, 1914 (Playfair 1915, 1917); Murray Valley, [collector not cited], 1987 (Noble and Happey-Wood 1987).
Specimen Examined: NEW SOUTH WALES: Campsie, *A.H.S. Lucas*, 1916 (NSW).
Description of Australian Specimens: Vegetative cells 115–190 µm (sometimes 50 µm; Playfair 1915) in diameter; as long as or somewhat longer than broad, wall thin (c. 2 µm thick; Playfair 1915); chloroplasts 4–6, narrow, making 1–1.5 turns, pyrenoids very numerous, and large relative to the width of the chloroplast.
Taxonomic Assessment: *Spirogyra crassa* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 126–330 µm long, (108–)126–165 µm in diameter, with plane end-walls; chloroplasts 6–12 making 0.5 of a spiral; pyrenoids numerous, large; conjugation scalariform, conjugation tubes formed equally by both gametangia, fruiting cells not swollen; zygospores ovoid to globose, 120–175 µm long, 80–100 µm in diameter, middle wall with irregularly distributed shallow pits (smooth; Randhawa 1959), brownish. Published descriptions of *S. crassa* vary between the monographs cited as well as between Australian reports. All Australian collections, except those reported by McLeod (1975), have generally fewer chloroplasts turning more times than those of overseas reports and these reports of the species are rejected. McLeod's record cannot be verified.

Spirogyra dubia Kütz., *Tab. Phycol.* 5: 8, pl. 24 fig. 4 (1855).
Known Distribution: North America, Europe, Africa, China.
Specimen Reported: QUEENSLAND: [s. loc., s. d.] (Pigram 1909).
Description of Australian Specimens: Vegetative cells 1.5–4 times as long as broad, end-walls plane; chloroplasts 2 making 1–2.5 turns; conjugation scalariform, conjugation tube formed equally by both gametangia; gametangia slightly swollen; zygospores ellipsoid to orbicular (calculated from illustration in Pigram 1909).
Taxonomic Assessment: *Spirogyra dubia* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dias 1992) by vegetative cells 40–50 µm in diameter, 1.5–5 times as long as broad, with plane end-walls; chloroplasts 2–3, making 2–8.5 turns; conjugation scalariform; gametangia largely swollen; zygospores oval to ellipsoid, 54–104 µm long, 40–65 µm in diameter, middle wall thick, smooth and brown. There are a number of species consistent with Pigrams drawings, including *S. irregularis, S. welwitschii* and *S. hymerae*. Without further information, such as vegetative cell dimensions, the determination cannot be confirmed and we reject the name *S. dubia*, for the Australian taxon.

Spirogyra flavescens (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema flavescens* Hassall, *Hist. Brit. Freshwater Alg.* 149, pl. 30 fig. 9–10 (1845).
Known Distribution: North America, Europe, Africa, Asia.

Specimens Reported: QUEENSLAND: [s. loc., s. d.] (Pigram 1909). VICTORIA: Albert Park Lake, *A.D. Hardy*, 30.xi.1954 (Hardy 1931–1956).

Description of Australian Specimens: Vegetative cells 20–21 µm in diameter, end-walls 'truncate' (Pigram 1909).

Taxonomic Assessment: *Spirogyra flavescens* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992) by vegetative cells 30–50 µm long (74–137 µm; Kargupta and Sarma 1992), 10–17 µm in diameter, with plane end-walls; chloroplast single, very thin, making 1–3 turns; conjugation scalariform (and lateral, Randhawa 1959), conjugation tubes formed equally by both gametangia; gametangia are distinctly swollen; zygospores long, ellipsoid to ovoid, 25–59 µm long, 18–23 µm in diameter; outer wall thin and brown, middle wall smooth and yellow (or bluish green; Randhawa (1959). Pigram's (1909) illustration is taken from Petit (1880) and the dimensions of the vegetative filament provided by Petit are outside the range reported generally for *S. flavescens*. Hardy's (1931–56) report is based on a vegetative specimen and includes no documentation. *Spirogyra flavescens* is therefore rejected from the census.

Spirogyra flavicans Kütz., *Tab. Phycol.* 5: 7, tab. 5, t. 23 fig. 3 (1855).

This species was reported by Hardy (1906) from Berwick, Victoria, Kützing (1882a) [as '*S. flavicans* var. artic. *longioribus*'] from Port Phillip, Victoria, and Watts (1887) from Victoria. This taxon is treated as *Spirogyra decimina* var. *flavicans* (Kütz.) Rabenh. by De Toni (1889).

Spirogyra fluviatilis Hilse in Rabenh., *Fl. Eur. Alg.* 3: 243 (1868).

This species was reported by Berg (1953) from the Upper Finke River, Northern Territory.

Spirogyra gracilis (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema gracile* Hassall, *Hist. Brit. Freshwater Alg.* 155, pl. 34 fig. 6 (1845).

This species was reported by Kützing (1882b) [s. loc.] and West (1909; also as '*S.* sp. (probably *gracilis*)') from Yan Yean Reservoir, Victoria.

Spirogyra hassallii (Jenner) Petit, *Spirogyra Paris* 13, pl. 2 figs 6–8 (1880). *Zygnema hassallii* Jenner, *Fl. Tunbridge Wells* 182 (1845).

This species was reported by Playfair (1917) from New South Wales.

Spirogyra lismorensis *nom. illeg.* Playfair, *Proc. Linn. Soc. New South Wales* 39: 98 (1914).

Known Distribution: Australia.

Specimens Reported: NEW SOUTH WALES: Richmond and Nymboida Rivers, *G.I. Playfair*, xii.1912–i.1913 (Playfair 1914, 1918).

Description of Australian Specimens: Vegetative cells 80–300 µm long, c. 14 µm in diameter, end-walls replicate, chloroplast single broad, twisted round its long axis, making 5–15 turns, edges somewhat laciniate.

Taxonomic Assessment: Playfair (1914, 98), in describing this species, stated 'I have given this curious and interesting form a name, but I do not consider it a distinct species.' Under article 34 of the ICBN (Greuter 1994), *Spirogyra lismorensis* must therefore be treated as an illegitimate name. In addition, the only material on which the name was based is sterile so no species determination is possible.

Spirogyra lubrica Kütz., *nom. nud.* (Day *et al.* 1995).

This species was reported by Kützing (1882b) from Victoria.

Spirogyra lutetiana Petit, *Brébissonia* 1: 79, pl. 6 (1879).

This species was reported by Laird (1956) from Toonpan Creek, Queensland.

Spirogyra majuscula Kütz., *Sp. alg.* 441 (1849).

This species was reported by Hardy (1906) from Deepdene, South Australia, Kützing (1882b) [s. loc.] and Watts (1887) from Victoria.

Spirogyra pellucida (Hassall) Kütz., *Sp. alg.* 439 (1849). *Zygnema pellucidum* Hassall, *Hist. Brit. Freshwater Alg.* 143, pl. 25 figs 1, 2 (1845).

This species was reported by Hardy (1906) from Deepdene, South Australia, Kützing (1882a) from Port Phillip, Victoria, and Watts (1865, as *Zygnema pellucidum*; 1887) from Victoria.

Spirogyra pseudoneglecta Czurda, *Süsswasserflora* 9: 194 (1932).

This species was reported by Laird (1956) from Civil Airfield, Cairns, Queensland.

Spirogyra punctata Cleve, *Nova Acta Regiae Soc. Sci. Upsal.* ser 3, 6: 23, pl. 4 figs 1–4 (1868).

All reports (Pigram 1909, Mc Leod 1975) of *Spirogyra punctata* from Australia are based on Moebius's var. *tenuior* (see that taxon above).

Spirogyra quadrata (Hassall) Petit, *Bull. Soc. Bot. France* 21: 41, pl. 1 fig. 2 (1874). *Zygnema quadratum* Hassall, *Hist. Brit. Freshwater Alg.* 157, pl. 37 figs 1, 2 (1845).

This species was reported by West (1909) from Yan Yean Reservoir, Victoria.

Spirogyra rectangularis Transeau, *Amer. J. Bot.* 1: 291, pl. 25 figs 9–11 (1914).

Known Distribution: North America, Europe, Australia.

Specimen Reported: QUEENSLAND: University Lake, St Lucia, *J.A. McLeod*, [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells 170–210 µm long, 35–40 µm in diameter, with replicate end-walls; chloroplasts 2, making 4 turns; no reproductive stages observed.

Taxonomic Assessment: *Spirogyra rectangularis* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 150–320 µm long, 35–40 µm in diameter, end-walls replicate; chloroplasts 2–4 making, 2–5 turns; conjugation scalariform and lateral; conjugation tubes formed equally by both gametangia (principally by male gametangia, Dillard 1990); gametangia cylindrically inflated to 48–70 µm; zygospores ovoid to cylindrical-ovoid, 75–120 µm long, 45–65 µm in diameter, middle wall smooth and yellow-brown. Although the Queensland collection matches the above description in its vegetative characters, without reproductive material it could be a number of species: e.g. *S. cleveana*, *S. borysthenica*, *S. areolata*. *Spirogyra rectangularis* is therefore rejected from our census.

Spirogyra weberi Kütz., *Phycol. General.* 279 (1843).
This species was reported by Playfair (1917) from New South Wales.

Spirogyra westii Transeau, *Trans. Amer. Microscop. Soc.* 53: 224 (1934).
Known Distribution: Africa, India.
Specimens Reported: NEW SOUTH WALES: Major Creek, Howell near Tinga, *Garrard*, iv-vii.1974 (Skinner 1980); Sandy Creek, near the dog-gate, Armidale-Dorrigo Road, *S. Skinner*, xii.1974 (Skinner 1980).
Description of Australian Specimens: Vegetative cells 20–25 µm in diameter, 4–5 times as long as broad, end-walls lenticular; chloroplast single, making 4–7 turns, pyrenoids numerous; conjugation scalariform, 'conjugation tube of two cups, towards one end of both donor and receiver cells, a little more terminally in the slightly inflated receiving cell'; zygospores ellipsoid, 65–70 µm long, 30–35 µm in diameter, suture line median, middle wall golden brown.
Taxonomic Assessment: *Spirogyra westii* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 60–160 µm long, 36–41 µm in diameter, with plane end-walls; chloroplast single, making 3–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia enlarged; zygospores ellipsoid or ovoid, 56–93 µm long, 35–38 µm in diameter, middle wall finely wrinkled or corrugate. The diameter of the vegetative filaments given by Skinner (1980) is considerably smaller than that in the description above, and the middle wall ornamentation is not described. The name *S. westii* is therefore rejected for Australia pending further evidence (no voucher specimens are housed at AD).

Zygnema aequale (Kütz.) De Toni, *Syll. Alg.* 1: 739 (1889). *Zygogonium aequale* Kütz., *Phycol. Germ.* 225 (1843).
This species was reported by Kützing (1882b, as *Zygogonium aequale*) from Ballarat, Victoria.

Zygnema gorakhporense Rama N. Singh, *J. Indian Bot. Soc.* 17: 370 (1938).
This species was reported by Laird (1956) from 16 km south of Townsville and Toonpan Creek, Queensland.

Zygnema leiospermum de Bary, *Unters. Conjugaten* 77, pl. 1 figs 7-14 (1858).
Known Distribution: North America, Greenland, Iceland, Europe.
Specimens Reported: QUEENSLAND: Lagoon, Isis, *J.A. McLeod*, [s. d.] (McLeod 1975); Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892; Bailey 1893, 1913). VICTORIA: Yan Yean Reservoir, *G.S. West*, ix.1907 (West 1909).
Description of Australian Specimens: Vegetative cells 22–24 µm in diameter, 1–1.5 (rarely less) times as long as broad, slightly constricted at the end-walls.
Taxonomic Assessment: *Zygnema leiospermum* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Kadlubowska 1972, 1984) by vegetative cells 20–40 µm long, 20–24 µm in diameter; conjugation scalariform; female gametangia greatly inflated, zygospores globose to ovoid, 23–32 µm long, 23–30 µm in diameter, middle wall smooth and brown; aplanospores similar to zygospores, but smaller in diameter. The description given by McLeod (1975) seems to be taken from published sources and her report cannot be accepted here. The vegetative filaments described by Moebius (1892) are consistent with *Z. leiospermum* as generally reported, but they also match species such as *Z. tenue*, *Z. calosporum* and

Z. peliosporum. The Victorian record is not documented at all. Pending further information, therefore, the name is rejected from our census.

Zygnema ralfsii (Hassall) de Bary, *Unters. Conjugaten* 77 (1858). *Tyndaridea ralfsii* Hassall, *Hist. Brit. Freshwater Alg.* 165, t. 39 figs 4-5 (1845).

Known Distribution: North America, Europe, Africa.

Specimen Examined: NEW SOUTH WALES: Woy Woy, *A.A. Hamilton*, vi.1915 (NSW).

Description of Australian Specimens: Zygospores globose to ellipsoid-globose, 27–39 µm long, 18–27 µm in diameter, middle wall scrobiculate and golden, pits c. 3 µm in diameter.

Taxonomic Assessment: *Zygnema ralfsii* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 38–80 µm long, 14–22 µm in diameter; conjugation scalariform; zygospores formed in the conjugation tubes, 24–35 µm long, 15–25 µm in diameter, middle wall smooth and brown. Only zygospores were found in the herbarium specimen and although they were of a similar size to those reported for *Z. ralfsii*, the middle wall was clearly scrobiculate rather than smooth. The name *Z. ralfsii* is therefore rejected from our census and without further documentation this collection cannot be identified.

Zygnema rhynchonema Hansg., *Hedwigia* 27: 257 (1888).

Known Distribution: Europe, North Africa.

Specimen Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1895; Bailey 1895, 1913).

Description of Australian Specimens: Vegetative cells c. 17 µm in diameter, 3–5 times as long as broad, walls thin, smooth; conjugation lateral; 'zygospore lies directly over, in front of the septum of both the conjugating cells', immature zygospores c. 38 µm in diameter.

Taxonomic Assessment: *Zygnema rhynchonema* is characterized (Borge 1913; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 16–20 µm in diameter, 2–6 times as long as broad; conjugation lateral; zygospores formed middle of conjugation tube, globose to ellipsoid, 30–35 µm long, 27–33 µm in diameter, middle wall smooth and blue. The cell dimensions of the Australian report match those generally reported for *Z. rhynchonema*, however, the zygospores are larger and there is no mention of the distinctive blue colour. Without further documentation this collection cannot be identified and the name *Z. rhynchonema* is rejected from our census.

Zygnema rivulare Hassall, *Ann. Nat. Hist.* 10: 38 (1842).

This species was reported by Watts (1865) from the Yarra River, Victoria.

Zygnema stellinum (Vaucher) C. Agardh, *Syst. Alg.* 77 (1824). *Conferva stellina* Vaucher, *Hist. Conferv. Eau Douce* 75 pl. 7 fig. 1 (1803).

This species was reported by Hardy (1906) from Royal Botanic Gardens, Melbourne, Victoria; Hardy (1931-56, as '*Zygnema stelligera*' [presumably in error]) from Yan Yean Reservoir, Victoria; Kützing (1882b; also '*Zygnema stellinum* ß') from Ballarat, Victoria, and Sonder (1852, 1880) from Tasmania.

Zygnema subtile Kütz., *Sp. alg.* 444 (1849).

This species was reported by Kützing (1882b) from Melbourne and Barwon River, Victoria.

Zygnema tenue Kütz., *Sp. alg.* 445 (1849).

This species was reported by Kützing (1882b) from Barwon River, Victoria.

Zygnema tenuissimum Grunov in Rabenh., *Fl. Eur. Alg.* 3: 251 (1868), *non* Hassall (1845).

Known Distribution: Europe.

Specimen Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892, 1895; Bailey 1893, 1913).

Specimen Examined: QUEENSLAND: Stony Creek, Blackdown Tableland, *A.B. Cribb 801.14*, 3.ix.1974 (BRI; Cribb 1976).

Description of Australian Specimens: Vegetative cells c. 9 µm in diameter, 10 times as long as broad; zygospores formed in the conjugating tube, spherical and brown, 16–20 µm in diameter.

Taxonomic Assessment: De Toni (1889) gives the same cell dimensions as above for *Zygnema tenuissimum* Grunov. However, the name *Z. tenuissimum* Grunov is a later homonym of *Z. tenuissimum* Hassall and is thus illegitimate. From the published description in Moebius (1892), the Bancroft collection is referable to *Z. spontaneum*. We were unable to identify the Cribb collection from the permanent slide available, but as Cribb (1976) reports it as '*Z. tenuissimum* Grun. *sensu* Moebius' it may be the same taxon.

Zygnemopsis desmidioides (West & G.S. West) Transeau, *Trans. Amer. Microscop. Soc.* 53: 215 (1934). *Debarya desmidioides* West & G.S. West, *J. Bot.* 1903: 7, pl. 446 figs 1–9 (1903).

This species was reported by Playfair (1917, as *Debarya desmidioides*) from New South Wales.

Zygogonium* [*Zygnema*] *affine Kütz., *Tab. Phycol.* 5: 4, pl. 12 fig. 3(1855).

This species was reported by Sonder (1880, 1881) from Tasmania.

Zygogonium laeve Kütz., *nom. nud.* (Day *et al.* 1995).

This species was reported by Kützing (1882b) from Melbourne, Victoria.

Zygogonium tenue Kütz., *Sp. alg.* 445 (1849).

This species was reported by Kützing (1882b) from Hawkesbury River, New South Wales.

Discussion

The nature of species in the Zygnemataceae has been, and continues to be, confusing. Hoshaw and McCourt (1988) suggest that *Spirogyra* and indeed the family, needs a thorough revision because of widespread polyploidy. McCourt *et al.* (1986) found correlation between filament width and nuclear-DNA content in a series of *Spirogyra* filaments collected from various habitats across continental USA, suggesting

'that species complexes in this genus may be widespread.' Hoshaw and McCourt (1988, 540) concluded that there were far fewer than the 386 species of *Spirogyra* included in Kadlubowska (1984). In Andersen (1992, 274), Hoshaw is quoted as saying that due to widespread polyploidy, 'the number of *Spirogyra* species [world-wide] is about 50 rather than 300', ultimately 'the definition of a species in this genus may need to be revised to include morphotypes of a species complex in the same species' (Hoshaw and McCourt 1988, 540).

The taxa accepted in this study form a first and tentative census of Zygnemataceae in Australia. For a family so diverse, so widespread and so patently common, the extent of collecting in Australia is woeful. This is due part to the difficulty in identifying sterile material, and in part to the overlapping and imprecise species definition and circumscription alluded to above.

The key we provide will assist in this process but is no substitute for a thorough taxonomic revision of the family in Australia involving culture studies, examination of type material and detailed population studies. The census and the key will give future collectors a relatively simple and consistent starting point. Clearly this paper does not fully document the diversity of Zygnemataceae in Australia. If our results induce collecting, identification, taxonomic revision and dissent we will have achieved our aim.

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Muelleria Vol. 11: 95–96 (1998)

Cleistocalyx fullagarii Transferred to *Syzygium* (Myrtaceae)

L.A. Craven

Australian National Herbarium, Centre for Plant Biodiversity Research, CSIRO Plant Industry, GPO Box 1600, Canberra, ACT 2601 Australia

Abstract

The endemic Lord Howe Island tree currently generally known as *Cleistocalyx fullagarii* (F. Muell.) Merr. & L.M. Perry is transferred to *Syzygium*, necessitating a new combination: *Syzygium fullagarii* (F. Muell.) Craven.

Introduction

Morphological observations were made on the Lord Howe Island plant, *Cleistocalyx fullagarii* (F. Muell.) Merr. & L.M. Perry (syn. *Acicalyptus fullagarii* F. Muell.), during studies directed towards preparation of *Flora of Australia* treatments for Australian representatives of the myrtaceous genera *Acmena* DC., *Acmenosperma* Kausel, *Piliocalyx* Brongn. & Gris, *Syzygium* Gaertn. and *Waterhousea* B. Hyland. Schmid (1972*a*, 1972*b*) concluded that *Acicalyptus* A. Gray and *Cleistocalyx* Bl. were not strongly distinctive from *Syzygium* and Hyland (1983) included the two Australian species of *Cleistocalyx*, *C. gustavioides* (F.M. Bailey) Merr. & L.M. Perry and *C. operculatus* Merr. & L.M. Perry, in *Syzygium*. However, Briggs & Johnson (1979) recognised both *Acicalyptus* and *Cleistocalyx*, and Smith (1985) recognised *Cleistocalyx* (incl. *Acicalyptus*) at generic rank, apparently giving strong weight to the calycine calyptra as a generic character.

Green (1994) treated the present species under *Cleistocalyx* in his account of the floras of several oceanic islands east of Australia. The plant is endemic to Lord Howe Island where it has the common name 'Scalybark'. Forming a large tree, it has been utilised locally as a timber source.

A calycine calyptra occurs in three Australian species of *Syzygium*, i.e. *S. canicortex* B. Hyland, *S. gustavioides* (F.M. Bailey) B. Hyland and *S. nervosum* DC. (*C. operculatus*). If the calycine calyptra is excluded from consideration, these three species are clearly not representatives of the same lineage and, to include all such species in the same taxon on the basis of possession of a calyptra, as was done by Merrill and Perry (1937), results in an unacceptably artificial classification of the plants in question. The calycine calyptra is best regarded as having evolved several times and possession of the feature should not be regarded as being of high significance for generic level classification in the *Syzygium* constellation of genera. Insofar as other morphological aspects are concerned, *Cleistocalyx fullagarii* possesses the following features that are characteristic of the genus *Syzygium* within that particular generic constellation: anther sacs parallel, placentation axile-median, seed without intrusive placental tissue that interlocks the cotyledons, cotyledons free. Accordingly, the Lord Howe Island plant is here transferred to *Syzygium*.

Syzygium fullagarii (F. Muell.) Craven, comb. nov.

Acicalyptus fullageri F. Muell., Fragm. 8: 15 (1873). *Cleistocalyx fullageri* (F. Muell.) Merr. & L.M. Perry, J. Arnold Arb. 18: 331 (1937).

Type: Lord Howe Island, *Fullagar 49* (lectotype, here designated, MEL, isolectotype MEL).

There are four sheets of material in MEL that I regard as being definite syntypes. Three of these are in fruit and apparently represent a single gathering. Of the sheets, one bears labels giving some details of the plant and giving the collector's name as Fullagar and the number 49; this sheet is designated the lectotype. One sheet apparently is a duplicate sheet retained in MEL while the remaining sheet is from the Sonder herbarium and probably was sent out by Mueller as a duplicate. The fourth sheet is in late bud and has the number 6 on a label that also bears the name *Acicalyptus fullagari* F.v.M., the name apparently being in Mueller's hand. No collector's name is given on this sheet. Mueller (1873) cited Lind as a co-collector of the Fullagar material but his name does not appear on any label. Similarly, no material has been seen that clearly can be referred to the Moore collection that was cited by Mueller. There are three other sheets in MEL that appear to date from the late 1800's. These bear adult and/or coppice or juvenile foliage with one of them bearing a fruiting twig and apparently represent a single gathering. The collection has been ascribed to 'Fullager' in a pencilled annotation on one label; this information may have been added later. The names on the three sheets, variously *Acicalyptus fullageri* F. von Mueller, *Acicalyptus fullagari* Mueller and *Acicalyptus fullageri* F.M., do not appear to be in Mueller's hand and the specimens probably are not to be treated as syntypes.

In the protologue, Mueller (1873) adopted the spelling 'fullageri' for the specific epithet although he gave the name of the person so commemorated as 'Fullagar'. As early as 1893 the orthography of the epithet had been changed to 'fullagari' (Moore 1893) and this was followed by most later authors, including Green (1994, as 'fullagarii') with the notable exception of Merrill & Perry (1937) who retained the original spelling. Although my preference generally is for the retention of original spellings, in the interests of stability in plant nomenclature, I have decided to follow the changed orthography (including the terminal *-ii*) as it has been widely used.

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Muelleria Vol. 11: 97–100 (1998)

Bracteantha palustris (Asteraceae: Gnaphalieae), a New Species in Victoria and Tasmania

C. Flann

c/o National Herbarium of Victoria, Birdwood Avenue, South Yarra, Victoria 3141, Australia.

Abstract

Bracteantha palustris C. Flann *sp. nov.* is described. Its distribution, habitat, conservation status and relationship to other species of *Bracteantha* are discussed. The status of both *B. bicolor* and *B. subundulata* var. *angustifolium* is discussed, and a key to all *Bracteantha* species in south-eastern Australia is provided.

Introduction

The opportunity is taken here to formally describe the entity known as *Bracteantha* sp. aff. *subundulata* (Ross 1996). It is not a recent field discovery but has been segregated as a result of a thorough comparison with *Bracteantha subundulata* (Sch. Bip.) Paul G. Wilson. Field observation and examination of herbarium specimens held at MEL and HO indicate that it is a distinct entity differing from the other species of *Bracteantha* in habitat as well as in morphological characteristics.

Taxonomy

Bracteantha palustris Flann *sp. nov.*

a *B. subundulata* (Sch. Bip.) Paul G. Wilson caule elatiore basin versus glabro, bracteis rasilibus, et in habatitione palustri differt.

Type: Victoria, Saplings Morass Flora and Fauna Reserve, 11 Dec. 1996, *C.Flann 1 & N.G.Walsh* (holotype MEL; isotypes HO, NSW, CANB)

Helichrysum acuminatum var. *angustifolium* DC., *Prod.* 6:188 (1838) (syntypes G, MEL)

Bracteantha sp. aff. *subundulata sensu* J.H. Ross *Cens. Vasc. Pl. Vict.* (1993, 1996).

Perennial herb, 30–100 cm tall. *Rhizomes* branched, horizontal, to 8 mm in diameter. *Stems* simple (rarely 1–2-branched), erect, with arachnoid hairs for 5–15 cm below capitulum, otherwise glabrescent. *Leaves* alternate, sessile, partially stem-clasping, lanceolate-elliptic, basal ones largest, 3–10 cm long, 3–8 mm wide, apex acute, margins entire with shortly spreading to appressed arachnoid hairs, internodes 2–7 cm long. *Capitula* solitary, terminal, heterogamous, 2.5–5.0 cm in diameter. *Involucral bracts* spreading, 8–12-seriate, narrowly elliptic, intermediate bracts longest, not distinctly clawed, 1.0–2.5 cm long, acute, rigidly scarious, golden-yellow, opaque, abaxial surface smooth at apex; outer bracts reflexed at maturity. *Receptacle* flat to slightly concave, 5–9 mm in diameter, smooth or with minute spinose ridges, sometimes with blunt-tipped setae between florets. *Female florets* few in a single discontinuous outer series, sometimes apparently absent, yellow, filiform, corolla 4–8 mm long; Bisexual inner florets, 6–8-seriate, yellow, tubular, corolla 7–8 mm long. *Anthers* ecalcarate, with short tails, apical appendage concave, as wide as the thecae. *Style* bifid, the branches clavate, with one dorsal furrow and with obtuse projections at tip. *Cypselas* oblong, cylindrical, but quadrangular in cross-section, c. 3 mm long, 0.5 mm wide, glabrous, smooth, those of female and bisexual florets similar. *Pappus* yellow, of free, barbellate capillary bristles, 5–8 mm long with a few longer barbs at the tips. (Fig. 1a–e.)

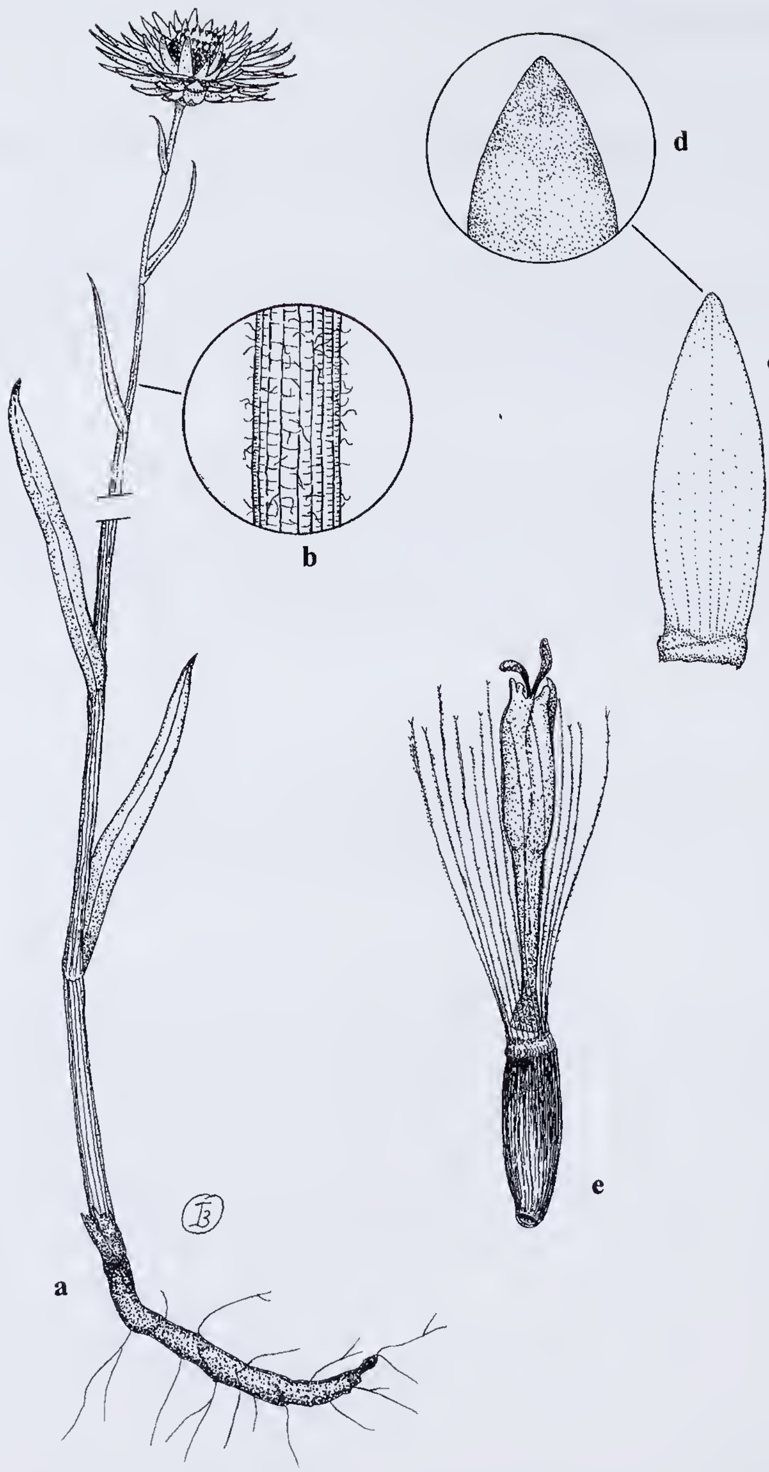

Fig. 1. *Bracteantha palustris* (*Flann 6*): **a** habit, x 0.5; **b** indumentum, x 6; **c** involucral bract, x 3; **d** abaxial surface of bract apex, x 9; **e** (*A.C. Beauglehole 17153*): **e** mature fruit just prior to abscission of corolla, x 8.

Etymology

The specific epithet (from the Latin, *palustris*, meaning swampy or marshy) refers to the habitat in which this species is found.

Distribution and Conservation Status

Known from a few sites in southern Victoria, from near the South Australian border to around Bairnsdale in the east, and in eastern Tasmania. The species is regarded as threatened and listed on Schedule 2 of the Flora and Fauna Guarantee (Victorian Government 1996). Most populations probably consist of few individuals as the principle method of reproduction appears to be vegetative in the form of an extensive rhizome system. The species is confined to swamps or winter-wet grasslands, and, while a few of the populations are in biological reserves, many are on uncommitted public land, such as rail reserves, or on private land. Doubtless it was more common prior to widespread vegetation clearance and swamp drainage of the Victorian lowland plains. The Risk Code (*sensu* Briggs & Leigh 1996) for *B. palustris* is assessed at 3RCi.

Habitat

Bracteantha palustris has been recorded exclusively in or adjacent to areas prone to inundation. The species is found in permanent swamps, winter-wet grasslands and swampy riparian vegetation. A tree canopy is absent from most sites in which it occurs, although, at one site near Bairnsdale, it occurs in a swampy *Eucalyptus tereticornis* woodland. Commonly associated species include *Amphibromus neesii*, *Villarsia reniformis*, *Eryngium vesiculosum* and *Lepidosperma longitudinale*. In most Victorian localities the soils are cracking black clays. The species is found at altitudes below 500 m. Flowering: Nov-Mar; fruiting: Dec-Apr.

Representative Specimens (30 specimens examined)

Tasmania: The Friendly Beaches Road, Freycinet, 10 Feb. 1984, *A. Moscal* (HO); South Lagoon, near Longford, 18 Dec. 1986, *R.J. Fensham* (HO).

Victoria: Argyle H.S., Lake Mundi, 7 Nov. 1983, *D. Headlam* (MEL); Lower Glenelg River Area 2.5 miles (4 km) SE of Drik Drik P.O., 25 Jan. 1970, *A.C. Beauglehole 33395* (MEL); Fenced plot c.400 m SW of Snake Valley-Streatham Rd & Chepstowe-Pittong Rd junction, 12 Dec. 1996, *C. Flann 6 & N.G. Walsh* (MEL); Swamp north of Pearson's road, Gellion's Run, West of Hedley, 7 Jan. 1981, *N.H. Scarlett NS81-24* (MEL); Saplings Morass Flora and Fauna Reserve, 3 Oct. 1984, *A.C. Beauglehole 77696* (MEL).

Notes

Bracteantha palustris appears to be most closely related to *B. subundulata* and can be distinguished by the following characteristics. The aerial stems of *B. palustris* have sparse to mid-dense arachnoid hairs for 5–15 cm below the capitulum whereas the indumentum of *B. subundulata* is dense and extends all the way to the base. The apical portion of the abaxial surface of the bracts is smooth in *B. palustris* as opposed to scabrous in *B. subundulata*. Further, *B. palustris* tends to be taller (30–100 cm) than *B. subundulata* (to 45 cm) and the leaves are generally narrower, tending to lanceolate rather than oblanceolate, the common state in *B. subundulata*. *Bracteantha palustris* occurs exclusively in wetlands below 500 m, whereas *B. subundulata* is restricted to alpine and subalpine zones generally above c. 900 m.

Prior to it being recognised as a distinct taxon (Ross 1993, 1996) this species had been included in *Bracteantha subundulata* (formerly *Helichrysum acuminatum* DC). *Bracteantha palustris* has also been identified as a wetland form of *B. subundulata* in Tasmania.

Most specimens of *B. palustris* at HO had been determined as *B. bicolor* (Lindl.) A. Anderb. & L. Haegi (formerly *Helichrysum bicolor* Lindl.), but comparison of specimens at K regarded as types of *B. bicolor* show that it is part of the *B. bracteata* (Vent.) A. Anderb. & L. Haegi complex (as noted by Curtis 1963) or even synonymous with that species. *Bracteantha bracteata sens. lat.* is a polymorphic assemblage that occurs in all states and territories of Australia and requires revision. Jim. H. Willis had noted on one of the *B. palustris* specimens at MEL that that it differs from *B. bicolor* in its quite simple stems, rhizomic habit, non-scabrid foliage and narrower more acuminate bracts which are essentially the same features that distinguish *B. bracteata.*

Type specimens of *Helichrysum acuminatum* var. *angustifolium* DC. at MEL and G are incomplete (both lacking intact capitula) but in all other respects match, and are here referred to *B. palustris.*

Key to South-eastern Australian species of *Bracteantha*

The remainder of the Australian species were not included in this key as they have not yet been taxonomically resolved.

1. Rhizomatous perennials 2
1. Tap-rooted annuals or perennials 3
2. Arachnoid hairs on stem extending to base; tips of involucral bract scabrous .... **B. subundulata**
2. Arachnoid hairs on stem extending 5–15 cm below capitulum; tips of involucral bract smooth .... **B. palustris**
3. Involucral bracts white; florets orange; Tasmania and islands of Bass Strait (and possibly Wilsons Promontory) .... **B. papillosa**
3. Involucral bracts and florets yellow; widespread 4
4. Leaves viscid, linear, to 0.4 cm wide .... **B. viscosa**
4. Leaves not viscid, elliptic, to 3.0 cm wide .... **B. bracteata**

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This study was undertaken as the inaugural Jim Willis Student at the National Herbarium of Victoria (MEL). Roger Riordan (Cybec Pty Ltd) deserves thanks for instigating this studentship in memory of his friend Jim Willis. I am grateful to the curators at HO, NSW and K for the promptly arranged loans of specimens and/or photographs. I am particularly indebted to Peter Jobson (formerly NSW) and Don Foreman (Australian Botanical Liaison Officer at K) for responding to requests quickly. Thanks to John Eichler and James Turner for providing information on populations of *B. palustris* in the field. I also thank all those at MEL for being so generous with their time and knowledge in introducing me to the intricacies of life at a herbarium, especially Neville Walsh who also furnished the Latin description. I would also like to extend my appreciation to Thomas Brosch (MEL) for the illustration of *B. palustris.*

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Sticherus urceolatus (Gleicheniaceae), a New Fern Species from Southern Australia

M. Garrett[1], *G. Kantvilas*[2], *and H. Laws*[3]

[1]PO Box 49, Bicheno, Tasmania 7215
[2]Tasmanian Herbarium, GPO Box 252–04, Hobart, Tasmania 7001
[3]75 Wellesley Street, South Hobart, Tasmania 7004

Abstract

Sticherus tener (R.Br.) Ching is revised and a new species, *S. urceolatus* M. Garrett & Kantvilas, is segregated. Both taxa occur in Tasmania and Victoria and are readily distinguished morphologically and cytologically. Descriptions of both species and two other southern Australian species, *S. lobatus* and *S. flabellatus*, are provided. Chromosome counts indicate that *S. urceolatus* is tetraploid whereas *S. tener* is diploid.

Introduction

The family Gleicheniaceae has been variously treated in the past. Initially it encompassed the one broad genus *Gleichenia* (e.g. Rodway 1903). Copeland (1947) recognised four genera, *Gleichenia*, *Sticherus*, *Dicranopteris* and *Hicriopteris*, whereas Holttum (1957) included only two, *Gleichenia* and *Dicranopteris*. In the latter treatment, *Gleichenia* is divided into the three subgenera *Gleichenia*, *Diplopterygium* and *Mertensia*, and the genus *Dicranopteris* is divided into the subgenera *Dicranopteris* and *Acropterygium*. Recent authors on Australian ferns (e.g. Jones and Clemesha 1981; Andrews 1990) have used a combination of these treatments, recognising four genera: *Gleichenia* (six species), *Sticherus* (four species), *Diplopterygium* (one species) and *Dicranopteris* (one species). Each of these genera has its own distinctive basic chromosome number (Walker 1966).

Within Australia, *Dicranopteris* occurs from New South Wales northwards, while *Diplopterygium* is confined to north-eastern Queensland (Andrews 1990). *Gleichenia* is wide-ranging, but most diversity is in the eastern States. *Sticherus* is confined to the eastern States: *Sticherus milnei* Baker (Ching) occurs on Cape York Peninsula, *S. flabellatus* (R.Br.) St. John in Queensland, New South Wales and Victoria, *S. lobatus* N.A.Wakefield in all eastern States, and *S. tener* (R.Br.) Ching (as previously treated) in New South Wales, Victoria and Tasmania.

The genus *Sticherus* is distinguished from the other three genera in having pinnatifid fronds bearing elongated branch-segments with once-branched veinlets, and by each segment bearing several sori, each with three to five sporangia. It contains approximately 90 species worldwide (Walker 1990).

Past treatments of *Sticherus* in Tasmania recognise two species: *S. lobatus*, which is uncommon to rare and localised mainly in the north-west, and *S. tener*, which is common and widespread (see Garrett (1996) for distributions). However, our field work in Tasmania suggested that a third species was also present. Robert Brown's type specimen of *S. tener* from Mt Wellington, Tasmania, proved to be quite distinct from the entity described and illustrated under that name by many previous workers, for example, Wakefield (1943, 1975), Thrower (1963), Willis (1970), Jones and Clemesha (1981) and Duncan and Isaac (1986). Accordingly, in this paper, we amend the description of *Sticherus tener s. str.* and describe the new species, *S. urceolatus*. A key and notes on the other southern Australian members of the genus are also included.

Methods

Taxonomic and ecological notes are derived from specimens held at the Tasmanian Herbarium (HO), the National Herbarium of Victoria (MEL) and the National Herbarium of New South Wales (NSW), and from observations in the field in Tasmania.

Sticherus leaf terminology follows that of Andersen and Øllgaard (1996). For an explanation of terms used see Figure 1.

Meiotic chromosome counts were made from aceto-carmine squash preparations. Segments bearing young sporangia were fixed in acetic-alcohol and the sporangia were later removed and squashed in aceto-carmine according to the method established by Manton (1950), care being taken to remove all empty sporangia and debris before placing the cover-slip.

Where a chromosome count could not be made with complete accuracy the number given is prefixed by "c.". Voucher specimens have been deposited in the Tasmanian Herbarium, the HO collection number being given with each chromosome number.

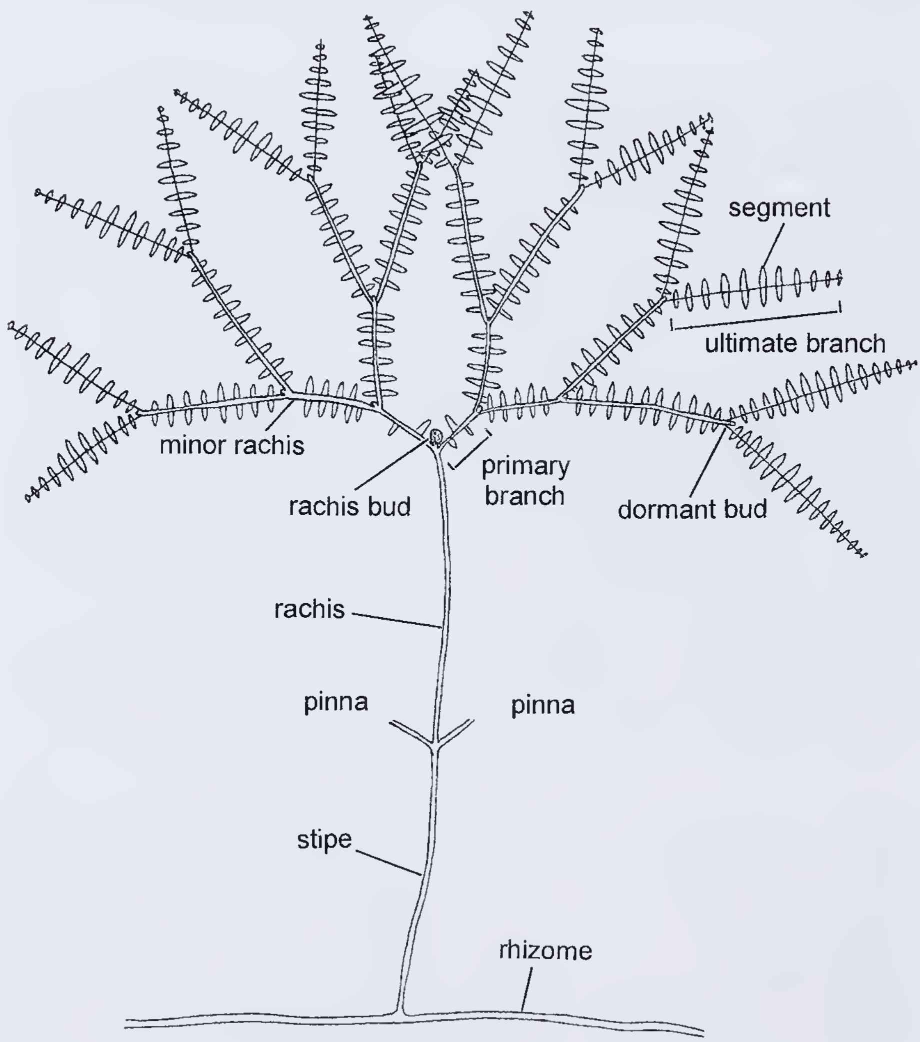

Fig. 1. Diagrammatic representation of a *Sticherus* plant, explaining terminology used

Key to southern Australian species of Sticherus

1. Ultimate-branch segments arising at near right angles (75–90°) to the axis.......... 2
1. Ultimate-branch segments arising obliquely (40–75°) to the axis........................ 3
2. Segment undersurface glabrous; undersurface of minor rachis glabrous or with broad, pale-brown, slightly fringed scales .... *S. lobatus*
2. Segment undersurface sparsely covered with pale-brown hairs (may become glabrous with age); undersurface of minor rachis covered in narrow, brown, heavily fringed scales... *S. tener*
3. Segment undersurface glabrous or with a sparse covering of hair-like scales; angle between primary branches of paired pinnae <45°......... *S. flabellatus*
3. Segment undersurface sparsely covered with pale-brown hairs; angle between primary branches of paired pinnae >45°.............................. *S. urceolatus*

Taxonomy

***Sticherus urceolatus* M. Garrett & Kantvilas, sp. nov.**

S. flabellato et *S. tenero* s. str. maxime similis sed ab hoc segmentis latioribus marginibus praecipue integris et pilos simplices vel ramosos infra ferentibus, angulo latiore inter ramos primarios, et ramis primariis comparate longioribus, ab illo praecipue angulo inter segmenta axemque multo angustiore et ramis ultimis lanceolatis differt.

Type: Tasmania, Freycinet Peninsula, Graham Creek, 2 km S of Wineglass Bay, 10.viii.1997, *M. Garrett s.n.* (holotype HO; isotypes BM, MEL, NSW, WELT).

Illustrations (all as *Sticherus tener*): Jones & Clemesha (1981): 205, fig. 284; Duncan & Isaac (1986): pl. 4; 74, figs 7.8C, 7.9, 7.10; Garrett (1996): 119, photos 142-3 (as *S. tener* form A).

Scrambling or thicket-forming terrestrial fern. Rhizome dark brown to black, to 4 mm thick, long-creeping, bearing semi-appressed, light brown to reddish brown, ciliate scales. *Stipes* stiff and erect, to 90 cm in length, arising up to 50 mm apart, black at the base, brown or green in the upper section, glabrous except for appressed scales at the base similar to those on the rhizome. *Pinnae* fan-shaped, paired at the stipe apex and with up to 4 annual increments of growth arising from the rachis bud, pseudodichotomously branched up to 4 times, with a dormant bud at each axis which rarely develops; angle between paired primary branches (45–)50(–75)°; ultimate branch (6–)9(–13) times the length of the primary branch, lanceolate, sometimes with a caudate apex. *Minor rachises* sparsely covered in brown, narrow, heavily fringed scales; ventral surfaces light to dark brown in colour. *Rachis bud* situated between paired primary branches; bud and basal section of new rachis growth bearing light or reddish brown ciliate scales. *Segments* on primary branch usually variable in size and coverage, on ultimate branch arising at (50–)55–65(–75)° to the axis, sessile, broadened at the base, with the apex obtuse or acute and margins entire or slightly crenate, (13–)15–27(–45) × 2–3 mm at the middle section of the ultimate branch; undersurfaces with pale brown, simple and branched hairs along midveins and veinlets. *Sori* exindusiate, in a single row either side of the segment midvein, situated halfway between the midvein and the segment margin on one branch of a forked veinlet, mostly absent from distal sections of both segments and ultimate branches, each with 3–5 large sporangia. *Spores* yellow, monolete, kidney shaped, (32–)36–42(–44) × (16–)18–22(–25) μm. (Fig. 2A)

Fig. 2. Photographs of *Sticherus* pinnae. **A** *Sticherus urceolatus*. Note the lanceolate-shaped ultimate branches bearing segments that are obliquely angled. **B** *Sticherus tener*. Note the linear-shaped ultimate branches bearing segments which arise at almost right angles to the axis.

Cytology

Chromosome number: n = 68, Tasmania, Hastings Caves Road, 23.xi.1995, *M. Garrett* (HO *321501*); n = c. 68, Tasmania, St. Marys, Gardiner Creek, 5.ii.1997, *M. Garrett* (HO *321500*). Relatively few chromosome numbers are known for the approximately 90 species of *Sticherus*, but the base number x = 34 has been established for the genus (Walker 1990). *Sticherus urceolatus* is therefore tetraploid. The taxon Thrower (1963) figured and described as *Gleichenia* (subgenus *Mertensia*) *tenera*, is in fact *S. urceolatus*; her chromosome count of n = 68 confirms those recorded here for Tasmanian collections.

Representative specimens

New South Wales: South Coast, Neenah Gorge, Nungatta Nat. Park, 5.iv.1986, *D.E. Albrecht* 2563 (MEL *690217*). Leura, Blue Mountains, 9.i.1941, *N.A. Wakefield* (MEL *1512231*). Govetts Leap, 2.4 km E of Blackheath, 26.i.1975, *R.G. Coveny & P. Hind* (MEL *528023*).

Tasmania: South Bruny Island, Waterfall Creek, 13.vii.1986, *M. Garrett & R. Purden s.n.*(HO *99248*). Roger River, c. 6 km SW of Trowutta, 7.iv.1985, *A. Moscal* 10549 (HO *401802*). Lewis River at Low Rocky Point track bridge, 1.iii.1985, *A. M. Buchanan* 5992 (HO *406700*). Forestier Peninsula, Fazackerleys Range, 30.i.1989, *A. Moscal* 17130 (HO *144554*). Montana Falls, 20.ii.1992, *M. Garrett s.n.*(HO *142648*). King River, 23.xii.1984, *P. Collier* 190 (HO *116466*).

Victoria: Eastern Highlands, Kalorama, Olinda Creek, 2 km NNW of Silvan Dam wall, 15.ii.1994, *G.S. Lorimer* 786 (MEL *2020104*). Dingoes Creek Road, 18 km NE of Foster P.O., 21.xii.1978, *A.C. Beauglehole* (MEL *1605292*). Mt Buffalo Nat. Park, 19.i.1988, *A.C. Beauglehole* (ACB *92545*), *N.A.F. Gibb & J.E. Stanwick s.n.*(MEL *1595673*). South Gippsland, Wilsons Promontory, 9.ii.1989, *E. Chesterfield* 2164 *& J. Bush* (MEL *1576053*). Mt Drummer, 14.vi.1941, *N.A. Wakefield* (MEL *1512546*).

Etymology

The specific epithet describes the vase-shaped habit of the plant's pinnae when growing in an exposed position.

Distribution and ecology

Sticherus urceolatus is endemic to Australia, occurring in Tasmania and Victoria where it is common and widespread, and along the Central Coast of New South Wales. The species grows in wet forests in areas of high rainfall from sea-level to 800 m a.s.l., in permanently moist clay soils beside streams, rivers and waterfalls, and on forested slopes. It is common in seepage lines on sheltered rock-faces where it may grow in soil at the top or base of outcrops, or in soil-filled seams in the rock. In disturbed sites such as road cuttings, track margins and on uprooted tree buttresses, the species may clothe the near-vertical substrate to the exclusion of other plants.

Notes

Since the earliest publications on Australian ferns, *Sticherus urceolatus* has been overlooked and submerged within other taxa. Hooker (1860) reduced Brown's taxon, *Gleichenia tenera*, to a variety of *G. flabellata*. Subsequently, Bentham (1878) and Bailey (1881) cite it as *G. flabellata* var. *tenera*, Rodway (1903) and Ewart (1930) include it within *G. flabellata*, whilst the majority of authors, including Wakefield (1943, 1975), Thrower (1963), Willis (1970), Jones and Clemesha (1981), Tindale (1982), Duncan and Isaac (1986), Wilson (1990) and Entwisle (1994) consider it conspecific with *Sticherus tener*. Although the heterogeneity within *S. tener s. lat.* is alluded to by Duncan and Isaac (1986) and Entwisle (1994), the first published recognition of the distinctiveness of *S. urceolatus* is by Garrett (1996) who refers to the taxon as "*Sticherus tener* form A".

As regards gross morphology, the new species is most similar to *S. flabellatus*. Both species possess fronds with ultimate-branch segments that are obliquely angled. *Sticherus flabellatus* is distinguished by its narrower segments with serrated margins, by its usually glabrous segment-undersurfaces, by the acute angle between its paired primary branches, and by its comparatively very short primary branches. However, there is likely to be greater confusion between *S. urceolatus* and *S. tener*, at least in Tasmania, where both species are common and widespread, where *S. lobatus* is uncommon and localised, and where *S. flabellatus* is not present.

Both *S. urceolatus* and *S. tener* possess hairs on the segment undersurfaces, a character which taxonomically has perhaps helped unite the two species in the past. However, they are obviously distinguishable by two macrocharacters: the angle of the segments to the axis of the ultimate branch (55–65° in *S. urceolatus*, 80–85° in S. *tener*) and the shape of the ultimate branch (lanceolate in *S. urceolatus*, linear in *S. tener*). These characters are easily discernible in Figures 2A and 2B. Furthermore, the ratio of the width of the ultimate branch (at its widest point) to its length is 1:4.3 (28 specimens measured) in *S. urceolatus*, compared with 1:5.7 (22 specimens) in *S. tener*.

Scales from all parts of *S. urceolatus* are marginally broader, less caudate, and lighter in colour than those of *S. tener*. *Sticherus urceolatus* also exhibits uniform gradation in the length of segments on the ultimate branch whereas segment length is noticeably uneven in *S. tener*. Segments are less likely to be present on the primary branch in *S. urceolatus* than in *S. tener* but, when present, are more inclined to be stunted or not of uniform size. The sori tend to cover less of the segment length of *S. urceolatus* than of *S. tener* and, in the latter species, are borne on segments nearer the distal end of the ultimate branch. The lamina of *S. urceolatus* is overall thicker textured and more glossy than that of *S. tener*, and the indentations of the sori are often noticeable on its upper surface.

When growing under severely exposed conditions, plants of both species are stunted, but the pinnae of *S. urceolatus* are held semi-erect and the frond is vase-shaped, whereas pinnae of *S. tener* are drooping and the frond umbrella-shaped. Sporelings are easily attributable to either *S. urceolatus* or *S. tener* because the first pair of pinnae display the distinguishing characters of segment angle and ultimate-branch shape.

The diploid *S. tener* is fairly stable in its morphological characters whereas the tetraploid *S. urceolatus* is infamous for its instability of characters (Thrower 1963, as *Gleichenia tenera*). Thus any plant presenting confusion as to its proper identity tends invariably to be *S. urceolatus*.

In Tasmania, the distributions of the two species are broad and seemingly co-extensive. However, *S. urceolatus* occurs mostly at or near sea-level, and only extends to higher altitudes in milder areas of the State such as Mount Victoria in the north-east. *Sticherus tener* is infrequently found in the north-east and on the north and east coasts, but is abundant at sea-level on the west and south coasts and from there extends inland up to at least 900 m a.s.l. Both species occasionally occur sympatrically under identical ecological conditions.

Sticherus urceolatus is easily distinguished from *S. lobatus* by the segments arising acutely to the axis of its ultimate branches, and by the presence of hairs on its segment undersurfaces.

Sticherus tener (R. Br.) Ching

Sunyatsenia 5: 285 (1940). *Gleichenia tenera* R. Br., *Prodromus Florae Novae Hollandiae*: 161 (1810). *Mertensia tenera* (R. Br.) Poiret in Lamarck, *Encyclopédie Méthodique, Botanique suppl.* 3: 670 (1814). *Gleichenia flabellata* var. *tenera* (R. Br.) Hook. f., *Flora Tasmaniae* 2: 131 (1858).

Type: Tasmania, Derwent, Table Mountain [≡ Mt Wellington], *R. Brown* 110 (syntype BM!). *Illustration:* Garrett (1996): 119, photo 144 (as *Sticherus tener* form B).

Scrambling or thicket-forming terrestrial fern. Rhizome dark brown to black, to 4 mm thick, long-creeping, bearing semi-appressed, dark brown, ciliate scales. *Stipes* stiff and erect, to 90 cm in length, arising up to 50 mm apart, black at the base, reddish brown or green in the upper section, glabrous except for appressed scales at the base similar to those on the rhizome. *Pinnae* fan-shaped, paired at the stipe apex and with up to 4 annual increments of growth arising from the rachis bud, pseudodichotomously branched up to 4 times, with a dormant bud at each axis which rarely develops; angle between paired primary branches (55–)70(–90)°; ultimate branch (3–)6(–9) times the length of the primary branch, linear. *Minor rachises* sparsely covered in brown, narrow, heavily fringed scales; ventral surfaces light to dark brown in colour. *Rachis bud* situated between paired primary branches; bud and basal section of new rachis growth bearing brown ciliate scales. *Segments* present on the primary branch, mostly of uniform size and coverage, on the ultimate branch arising at (75–)80–85(–90)° to the axis, sessile, broadened at base, with the apex obtuse or acute and margins entire or slightly crenate, 8–15(–20) × 2–3 mm at the middle section of the ultimate branch; undersurfaces with pale brown, simple and branched hairs along midveins and veinlets. *Sori* exindusiate, in a single row either side of the segment midvein, situated halfway between the midvein and the segment margin on one branch of a forked veinlet, usually present near distal sections of both segments and ultimate branches, each with 3–5 large sporangia. (Fig. 2B)

Cytology

Chromosome number: n = 34, Tasmania, Newall Creek, 7.xii.1996, *M. Garrett* (HO *321499*). The diploid number found in *S. tener* distinguishes this species from tetraploid *S. urceolatus.*

Representative specimens

Tasmania: Arm River below Arm Falls, 19.ii.1992, *M. Garrett s.n.*(HO *142647*). Neasey Creek, 29.iii.1984, *A. Moscal* 7235 (HO *404197*). Zeehan, 27.iv.1976, *L. Richley* 263 (HO *30469*). Serpentine Dam, near Strathgordon, 6.viii.1981, *P.J. Brownsey* (HO *52503*). Dunning Rivulet, 18.ii.1986, *A.M. Buchanan* 8282 (HO *405197*). Upper Spence River, 27.iii.1985, *A.M. Buchanan* 6432 (HO *406537*). Kermandie River, 11.v.1993, *A. Moscal* 10870 (HO *403183*).

Victoria: Otway Ranges, 1.4 km from Seaview Road junction, 31.xii.1973 (MEL *522725*). Otway Ranges, 3.ix.1966, *A.C. Beauglehole* (MEL *1502833*). Gellibrand River Road, 21.ii.1982, *B. Duncan* (MEL *1541790*). Otways, Carlisle River, Lavers Hill Road, 9.iv.1991, *S. Glissman-Gough* D 2780 (MEL *1599051*). Federal Track, Stirling Gap, Powelltown, 17.v.1964, *R. Filson* 6405 (MEL *643118*). Otway Ranges, Turtons Track fern gully, 17.ix.1950, *L.G. Dale* (MEL *1502829*). Otway Ranges, W of Lavers Hill, 14.xi.1959, *A.C. Beauglehole* (MEL *1502830*). Board of Works, Maroondah Catchment in Watts River area, 19.iii.1979, *B. Duncan* (MEL *1541785*, *1541786*, *1541787*). Aire Valley Road, S of Beech Forest, 21.ii.1982, *B. Duncan* (MEL *1541793*).

New Zealand: South Island, Dusky Sound, Five Finger Peninsula, 13.xi.1984, *A.F. Mark* (OTA *41949*) (seen only in photocopy).

Distribution

Sticherus tener is common and widespread in Tasmania where it ranges from sea-level to at least 900 m a.s.l. It is far more common in the western half of the State than in the east. It grows in habitats similar to those of *S. urceolatus*, the two species sometimes growing together. It is uncommon in Victoria and localised in the Otway Ranges and near Powelltown. The species has recently been discovered in the South Island of New Zealand (B. Parris *in litt.*).

Notes

The distinguishing characters between *S. tener* and *S. urceolatus*, its closest relative, have been discussed under the latter species (above). In brief, *S. tener* is characterised by its linear-shaped ultimate branch, and by the segments of the ultimate branch which arise at 80-85° to the axis. *Sticherus tener* and *S. lobatus* may also be easily confused, although due to the scarcity or the limited distribution of either one in Tasmania and Victoria, the two species are not commonly found together. *Sticherus lobatus* lacks hairs on the undersurfaces of its pinnae segments and overall is a much more robust plant with larger parts. Undersurfaces of the minor rachises in *S. tener* are covered in brown, narrow, heavily fringed scales while those of *S. lobatus* have translucent, pale brown, broad scales and become glabrous with age. *Sticherus tener* and *S. flabellatus* are unlikely to be confused as they differ markedly in the shape of their ultimate branches and in the angle of their segments. In addition, their known ranges of distribution do not overlap.

Sticherus lobatus N.A. Wakefield

Victorian Naturalist 60: 110 (1943).

Type: Victoria, Mt Drummer, *N.A. Wakefield s.n.*, 6.vii.1941 (holotype MEL!).

Illustrations: Wakefield (1943): 109, fig. 1.1; Duncan & Isaac (1986): 74, fig. 7.8B; Garrett (1996): 118, photo 141.

Frond with fan-shaped pinnae, paired at the stipe apex, and with annual increments of growth arising from the rachis bud situated between paired primary branches; angle between paired primary branches (40–)75–80(–110)°; ultimate branch linear to lanceolate; average ratio of ultimate branch length to primary branch length 6:1. *Minor rachises* glabrous in old growth, sparsely covered in broad, pale brown to near-transparent scales in new growth; ventral surfaces yellow to brown in colour. *Segments* present on the primary branch, mostly of uniform size and coverage, arising at (75–)80–85(–90)° to the axis on the ultimate branch, with mostly entire margins; undersurfaces glabrous, mostly 20–30 × 2–3 mm at the middle section of the ultimate branch (sori never meeting segment margin and midvein).

Additional descriptions are provided by Duncan and Isaac (1986) and Thrower (1963).

Cytology

Chromosome number: $n = 34$, Tasmania, River Leven, Dial Creek, 21.xi.1996, *M. Garrett* (HO *320624*). This confirms the previously published count for the species (Thrower 1963).

Representative specimens

New South Wales: Clyde Mountain, 12.vi.1950, *J.E. Gauba* (MEL).

Tasmania: Newhaven Road, 10 km S of Rocky Cape township, along Alarm River, 10.iv.1984, *G. Kantvilas* 86 (HO *76698*). Lowrana Road, King River, a few km before Teepookana Bridge, 5.iii.1992, *M. Garrett s.n.*(HO *143401*). River Leven, 18.ii.1992, *M. Garrett s.n.*(HO *142649*).

Victoria: East Gippsland, 52 km N of Orbost on Bonang Hwy, 2.i.1983, *K.R. Thiele* 452 (MEL *1524156*). Powelltown, off Pioneer Creek Road, 25.ii.1976, *B.D. Duncan* (MEL *1541808*).

Distribution

Sticherus lobatus is endemic to Australia, occurring in Tasmania and Victoria where it is uncommon to rare, and in New South Wales and south-eastern Queensland where it is relatively common.

Notes

Sticherus lobatus may be confused with *S. tener*, this being especially so in Tasmania where large specimens of the latter species are common. The two are quite distinct, however, and distinguishing characters are discussed under the latter species. *Sticherus lobatus* is unlikely to be confused with either *S. urceolatus* or *S. flabellatus* because of its ultimate branch segments which arise at 80–85° to the axis (less than 75° in *S. urceolatus* and *S. flabellatus*).

Sticherus flabellatus (R. Br.) St. John

Occasional Papers of the Bernice P. Bishop Museum 17: 81 (1942). *Gleichenia flabellata* R. Br., *Prodromus Florae Novae Hollandiae*: 161 (1810).

Type: [New South Wales] Port Jackson, *R. Brown* 109 (holotype BM!).

Illustrations: Wakefield (1943): 109, fig. 1.3; Duncan & Isaac (1986): 74, fig. 7.8A; Jones & Clemesha (1981): pl. 43; 204, fig. 282; Brownsey & Smith-Dodsworth (1989): pl. 11F; 58, fig. 58.

Frond with fan-shaped pinnae, paired at the stipe apex, and with annual increments of growth arising from the rachis bud situated between paired primary branches; angle between paired primary branches (20–)30(–45)°; ultimate branch roughly lanceolate; average ratio of the ultimate branch length to primary branch length 25:1. *Minor rachises* glabrous or with occasional hair-like scales; ventral surfaces yellow to brown in colour. *Segments* usually absent from the primary branch, or few and stunted, arising at (40–)50–60(–65)° to the axis on the ultimate branch, with serrate or crenate margins; undersurfaces glabrous or with a few hair-like scales, mostly 20–40 × 1.5–2 mm at the middle section of the ultimate branch (sori may meet segment margin and midvein).

Additional descriptions are provided by Duncan and Isaac (1986) and Thrower (1963).

Cytology

This species was not available for chromosome studies but has previously been reported as $n = 34$ (Brownlie 1961; Thrower 1963).

Representative specimens

New South Wales: Hornsby, in sandstone country, 30.xii.1940, *N.A. Wakefield* (MEL *1512553*). Eden, in scrub by creek, 5.ix.1940, *N.A. Wakefield* (MEL *1512552*).

Queensland: Noosa, 18.iii.1943, *N.A. Wakefield* 394 (MEL *1512517*). Near Mt Coorey, 29.xi.1942, *N.A. Wakefield* 392 (MEL *1512556*). Robinson Gorge Nat. Park, upstream part of main gorge in Get Down section, 11.ix.1992, *P.I. Forster* (PIF 11261) *& P.R. Sharpe* (MEL *715965*).

Victoria: Junction of Boggy Creek track and Hard to Seek Creek, 15.xi.1988, *R.K. Humphries & G.E. Earl* (MEL *1564432*). Junction of Betka River and Mines Track, 11.xii.1988, *R.K. Humphries & G.E. Earl* (MEL *1564437*). Rainforest at Dowell Creek, vicinity of Duncans Road Crossing, near State border, NE of Mallacoota Inlet, East Gippsland, 20.iv.1976, *D. Cameron* (MEL *1541832*).

Distribution

Sticherus flabellatus occurs in extreme eastern Victoria where it is rare, and in New South Wales and Queensland where it is far more common. The species also occurs in both the North and South Islands of New Zealand, New Caledonia and New Guinea. It is absent in Tasmania and all earlier records, e.g. Brown (1810) and Rodway (1903), are mis-identifications of *S. urceolatus* and *S. tener*.

Notes

Sticherus flabellatus could be confused only with *S. urceolatus*. It is distinguished by its narrower segments with serrated margins, by its usually glabrous segment-undersurfaces, by the acute angle between its paired primary branches, and by its comparatively short primary branches.

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Notes on the *Eriostemon myoporoides* (Rutaceae) Species Complex, Including New Names and a New Generic Placement in *Philotheca*

Michael J. Bayly

School of Botany, The University of Melbourne, Parkville, Vic. 3052, Australia.

Present Address: Museum of New Zealand Te Papa Tongarewa, P.O. Box 467, Wellington, New Zealand. Email: michaelb@tepapa.govt.nz

Abstract

On cladistic grounds, and in line with a classification to be adopted for the treatment of Rutaceae in *Flora of Australia*, *Eriostemon myoporoides* DC. (including six currently recognised subspecies) is transferred to the genus *Philotheca* Rudge. Three new subspecies within this complex are described: subsp. *brevipedunculata*, from around Deua National Park in south-east New South Wales; subsp. *euroensis*, from near Euroa in Victoria; subsp. *obovatifolia*, from mountains near the south-east Queensland border. A key to subspecies is included, and brief notes and photographs are provided for all taxa.

Introduction

There is evidence (both morphological and cytological) suggesting the current circumscription of *Eriostemon* Sm. is polyphyletic (Smith-White 1954; Armstrong 1991; Stace *et al.* 1993; Bayly and Ladiges unpublished). Accordingly, Wilson (in press) has proposed a new classification wherein *Eriostemon* is restricted to *E. australasius* Pers. (the type of the genus) and *E. banksii* A.Cunn. ex Endl. (its sister species, Bayly *et al.* 1998), and remaining taxa transferred to the genus *Philotheca* Rudge. In line with this classification, and in preparation for the treatment of Rutaceae in volume 26 of *Flora of Australia*, being prepared by Paul Wilson, PERTH, taxa currently placed in the *E. myoporoides* DC. species complex are here treated under *Philotheca*, and the appropriate combinations published (Wilson, being aware of the impending publication of this present work, has not dealt with these taxa in his classification).

Members of the *Philotheca myoporoides*[1] complex are woody, aromatic shrubs that occur throughout much of south-eastern Australia; largely between the eastern coast and the slopes of the Great Dividing Range, from Kroombit Tops (Queensland) in the north to near Healesville (Victoria) in the south, extending inland to the south and central western slopes and south western plains of New South Wales (terminology follows Jacobs and Pickard 1981). Wilson (1970) listed three characters that, in combination, distinguish members of this complex from other members of section *Erionema*. These are: completely glabrous vegetative parts, leaves ending in an almost cuspidate point, and pedunculate inflorescences.

At present, six subspecies are recognised within *Philotheca myoporoides* (Wilson 1970, as *Eriostemon myoporoides*; Fig. 1). Three further entities are here considered worthy of taxonomic recognition: one from around Deua National Park in south-east New South Wales (Fig. 2), one from near Euroa in north-east Victoria (Fig. 3), and one from the border ranges of south-east Queensland (Fig. 4).

[1] See Taxonomic Treatment for authors of names in the *P. myoporoides* complex. Where authors of other taxa are not stated, they are as given by Wilson (in press).

Fig. 1. Examples of the six subspecies of *Philotheca myoporoides* recognised by Wilson (1970, as *E. myoporoides*). **A** subsp. *acuta* (MJB 174, Mt. Bunganbil, NSW). **B** subsp. *epilosa* (MJB 270, Boonoo Boonoo National Park, NSW). **C** subsp. *leichhardtii* (MJB 129, Mt. Ngungun, Qld). **D** subsp. *conduplicata* (MJB 268, Macintyres Falls, NSW). **E** subsp. *myoporoides* 'typical form' (MJB 208, Glenbrook causeway, Blue Mountains, NSW). **F** subsp. *queenslandica* (MJB 131 Landsborough, Qld).

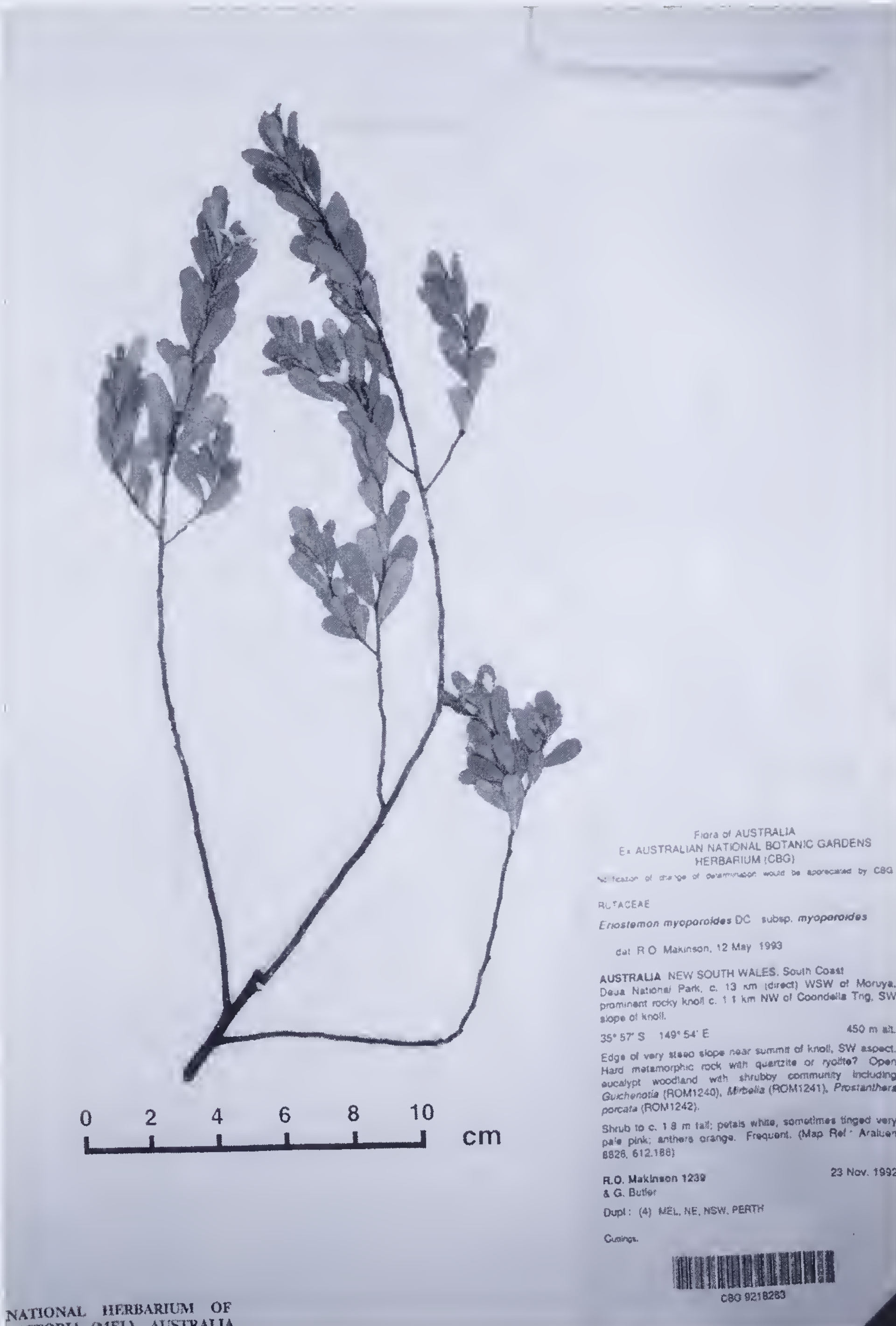

Fig. 2. Holotype of *Philotheca myoporoides* subsp. *brevipedunculata.*

Fig. 3. Holotype of *Philotheca myoporoides* subsp. *euroensis*.

Fig. 4. Isotype of *Philotheca myoporoides* subsp. *obovatifolia*.

For the most part, taxa in the *Philotheca myoporoides* complex are both morphologically and geographically distinct (see notes included in Taxonomic Treatment). Leaf shape and size (Figs 1-4), the degree of folding of the leaf lamina, the number of flowers per inflorescence, inflorescence size (e.g. peduncle length), and the distribution of hairs on the staminal filaments are useful features for the discrimination of taxa. Most taxa overlap on a number of these features, and each is largely defined by some unique combination of attributes.

Preliminary cladistic analysis of morphological and leaf flavonoid data (Bayly and Ladiges unpublished) is equivocal regarding the monophyly of the complex; placing its members (with subsp. *leichhardtii* and subsp. *queenslandica* as sister taxa) as part of a large polychotomy including *Philotheca verrucosa* and a clade comprising *P. buxifolia*, *P. scabra* and *P. hispidula*. None of the features typically used in the classification of section *Erionema* (to which all these taxa belong) is synapomorphic for members of the *P. myoporoides* complex, and it seems probable that it is paraphyletic.

Given this, there would be some justification for the recognition of some or all taxa in the complex at species level (and several have names available at that level). However, in lieu of a more comprehensive revision, and in the absence of more detailed information of relationships, this present work retains a broad circumscription of *Philotheca myoporoides*, and describes new taxa at the rank of subspecies.

Herbarium Material and Field Collections

The treatment presented here is based on examination of herbarium material from BRI, NE, NSW, CANB, MEL, MELU, and AD (herbarium abbreviations follow Holmgren *et al.* 1990). Between 1991 and 1996, all currently-recognised subspecies were observed in the wild, as was a distinctive population near Euroa, in north-east Victoria.

Taxonomic Treatment

Descriptions are only provided for new taxa. Details of other taxa can be found in Wilson (1970) but, where appropriate, notes are provided to supplement the information in this work. Specimen citations and distribution are deliberately abbreviated for subsp. ***euroenis.***

Philotheca myoporoides (DC.) M. J. Bayly, comb. nov.

Eriostemon myoporoides DC., *Prod.* 1:720 (1824). Type: Nouv. Holl. cote orient, Mus. de Paris 1821. (holotype G-DC (IDC microfiche seen)).

E. amplifolius F.Muell., *Australasian Chem. and Druggist* 7: 64 (1884). Type citation: "on the Upper Genoa some years ago an *Eriostemon* was discovered by Mr. C. Walter" (type not located, see notes in Wilson, 1970).

Philotheca myoporoides, as treated here, includes nine subspecies. The following key to subspecies works best with herbarium material. In particular, the extent of folding of the leaf lamina in the dried state (as used in the key), may not be indicative of the fresh condition (e.g. Victorian forms of subsp. *myoporoides* may be strongly concave to conduplicate in the field, but almost always appear flat on herbarium sheets).

In addition to the taxa discussed below, there is a variant represented by two collections from Mt Stewart in Victoria (*K. Rogers*, MEL *4133*; *J. Turner 1055*, MEL *2030756*) that does not sit comfortably within the present circumscriptions of subspecies (and is not included in the key below). Superficially, these collections most closely resemble members of subsp. *brevipedunculata* (described below). They have

leaves that are obovate with an obtuse apex, 8–15 mm long, 3–6 mm wide, and concave above. Inflorescences have peduncles 0.5–2.5 mm long, and 1–4 (mostly 1–3) pedicels, which are 2–2.5 mm long. The petals are 4–6 mm long, and the staminal filaments are pilose toward the apex. The natural range of this variant, and its relationship to other members of the complex is worthy of further investigation.

Key to Subspecies of *Philotheca myoporoides*

1. Leaves 13–30 mm long, 5–10 mm wide, oblong-elliptic to obovate; inflorescences of 1(–3) flowers; peduncles to 2 mm long, sometimes scarcely visible; pedicels 4–8 mm long (south-east NSW).........**4.** subsp. ***brevipedunculata***
1. Without the above combination of features 2
2. Leaves strongly conduplicate when dry..3
2. Leaves flat or somewhat concave when dry 5
3. Leaves < 35 mm long (Vic.)..**5.** subsp. ***euroensis***
3. Leaves mostly > 40 mm long (NSW, Qld)..4
4. Branchlets prominently glandular-verruose; leaves often >10 mm wide (south-east NSW), some populations of the mountain form of .....**1.** subsp. ***myoporoides***
4. Branchlets almost smooth; leaves 4–10 mm wide (Granite Belt of north-east NSW and south-east Qld)...**7.** subsp. ***conduplicata***
5. Leaves oblong to obovate, flat to somewhat concave, 20–50 mm long, 4–10 mm wide, midrib evident on lower surface; inflorescences of 1–3 (mostly solitary) flowers; pedicels 6–11 mm long; stamen filaments usually (but not always) long-pilose toward the apex (Glasshouse Mountains, Cania Gorge and Kroombit Tops
areas of south-east Qld.) .... **8.** subsp. ***leichhardtii***
5. Without the above combination of features 6
6. Leaves more or less flat when dry 7
6. Leaves somewhat concave when dry...8
7. Leaves oblong to elliptic (Vic. and NSW) ....**1.** subsp. ***myoporoides***
7. Leaves obovate (Mt Barney area of south-east Qld.) ....**6.** subsp. ***obovatifolia***
8. Leaves obovate; apex of staminal filaments glabrous or with a few hairs ('Granite Belt' of north-east NSW and south-east Qld)................**3.** subsp. ***epilosa***
8. Leaves (often narrowly) oblong, elliptic or oblanceolate; apex of staminal filaments pilose 9
9. Leaves (15–)40–45(–52) mm long, 2–8 mm wide, deeply to slightly concave when dry; inflorescences of up to 5 flowers (but often 1 or 2-flowered); peduncle to 7 mm long; pedicels 3–11 mm long; apex of stamen filaments pilose (central and
western NSW)...**2.** subsp. ***acuta***
9. Leaves 10–30 mm long, 1.5–4 mm wide, deeply concave when dry; flowers solitary; peduncle to 5 mm long; pedicels 3–5 mm long; apex of stamen filaments long-pilose (near-coastal areas of south-east Qld) ....**9.** subsp. ***queenslandica***

1. *Philotheca myoporoides* subsp. ***myoporoides***

E. cuspidatus A. Cunn., in B. Field, *Geogr. Mem. N.S. Wales* 331 (1825). Type: Cox's River, *A. Cunningham 54*, Oct. 1882. (holotype K, *fide* Wilson 1970).

E. nerifolius Sieber ex Spreng., *Syst. Veg.* 4/2: 164 (1827). Type: Fl. Novae Holl, *F. W. Sieber 306* (isotypes K (*fide* Wilson 1970), MEL *4537*, *4190)*.

E. lancifolius F.Muell., *Trans. Vict. Inst.* 1: 32 (1855). Type citation: "on the stony summit of Mt. McFarlan, at an elevation of nearly five thousand feet on Mt. Tambo and the Upper Mitta Mitta". (syntypes K (*fide* Wilson 1970), MEL *4165* (?mixed collection, Mt Tambo and upper Mitta Mitta, 4-5000'); MEL *4157*, *4176* (Mt Tambo); MEL *408*, *4177*, *4178* (Mt McFarlan)

Subspecies *myoporoides* is the most widespread and most variable member of the complex. It occurs along the Great Dividing Range from near Denman in New South Wales to near Healesville in Victoria (Queensland populations included in subsp. *myoporoides* by Wilson (1970) are described here as subsp. *obovatifolia*).

The typical, linear-leaved form of subspecies *myoporoides* (Fig. 1E) occurs in New South Wales from near Denman southward. It is often associated with watercourses and is most commonly collected in the Blue Mountains, along the Nepean and Bargo Rivers and their tributaries, and in isolated areas along the coastal ranges south to about Batemans Bay. This form is probably distinct from a form with thicker and more oblong-elliptic leaves, that occurs in the mountains of the ACT, southern New South Wales and eastern Victoria (to which the name *Eriostemon lancifolius* F.Muell. applies). These mountain populations (the 'mountain form') are between themselves variable, and occur in a range of habitats, from exposed and/or rocky sites in subalpine woodland (e.g. Lake Mountain in Victoria, Tinderry Range in New South Wales), to sheltered sites on deep soil in tall open-forest (e.g. near Toolangi in Victoria). Wilson (1970) suggested that plants of this latter, mountain form also occur in the Blue Mountains (to which the name *E. cuspidatus* A. Cunn. could apply), but any material I have seen from this region appears to have more affinity with typical *P. myoporoides* than with the mountain form (although I have not seen the type of *E. cuspidatus*).

While the extreme forms of subsp. *myoporoides* are quite distinct, the pattern of variation within this taxon is not straightforward. There are a range of localised forms (within or in addition to those mentioned here), and the nature of variation between these populations requires clarification.

2. *Philotheca myoporoides* subsp. ***acuta*** (Blakely) M. J. Bayly, comb. nov.

Eriostemon myoporoides var. *acutus* Blakely, *Contr. N.S.W. Natl Herb.* 1: 124 (1941); *E. myoporoides* subsp. *acutus* (Blakely) Paul G. Wilson, *Nuytsia* 1: 40 (1970). Type: 10 mi [16 km] north of Grenfell, *R. H. Cambage*, 1.x.1900. (holotype NSW *68728*).

E. affinis Sprague, *Gard. Chron. III.* 33: 307 (1903). Type: cultivated Kew. (holotype K (photo seen)).

[*E. myoporoides* var. *minor* auct. non Benth: Benth., *Fl. Austral.* 1: 333 (1863), *p. p.* (Lachlan River specimen).]

This subspecies occurs on the central and south western slopes, and north and south western plains of New South Wales. It is a bushy shrub to c. 1.8 m and grows in rocky areas on hills, especially on sandstone (Norris and Thomas 1991). It displays some variation in leaf size, ranging from 15 mm long and 2 mm wide, to 52 mm long and 8 mm wide. It can be distinguished from subsp. *myoporoides* by its smaller, oblong-elliptic leaves, and its inflorescences, which have 1–2(–5) [rather than (1–)3–9(–13)] flowers. The type of *E. affinis* has leaves and peduncles that, in terms of length, are at the upper limits of those found in subsp. *acuta*, but the lamina shape and degree of concavity suggest that it is best placed within this taxon.

3. *Philotheca myoporoides* subsp. ***epilosa*** (Paul G. Wilson) M. J. Bayly, comb. nov.

Eriostemon myoporoides subsp. *epilosus* Paul G. Wilson, *Nuytsia* 1: 41 (1970). Type: Wallangarra, Queensland, *S. L. Boorman*, Nov. 1906. (holotype NSW *69255*; isotype: NSW *68741*).

Subspecies *epilosa* is a compact, low-growing shrub to c. 1 m high, and often grows in thin soil pockets on exposed granite surfaces, in the granite belt of north-east New South Wales and south-east Queensland. It is broadly sympatric with subsp. *conduplicata* (Fig. 1d) but, as noted by Wilson (1970), there is no evidence of intergradation

between these taxa. Subspecies *epilosa* (Fig. 1B) has glandular-verrucose branchlets, obovate leaves about 2 cm long, inflorescences with predominantly solitary flowers, and staminal filaments that are epilose or with a few hairs at the apex. Subspecies *conduplicata* (Fig. 1D) has comparatively smooth branchlets, elliptic leaves up to c. 7 cm long that tend to be conduplicate and falcate, inflorescences with 1–4 pedicels and stamen filaments that are sparsely pilose at the apex. A conservation code of 3RCa has been proposed (Richards and Hunter 1997).

4. *Philotheca myoporoides* subsp. ***brevipedunculata*** M. J. Bayly, subsp. nov.

Ramuli dense verrucosi. Folia oblonge elliptica vel leniter obovata, apice obtusa vel truncata, 15–25 mm longa. Pedunculi ad 2 mm longi, interdum vix manifesti, vel absentes. Pedicelli 1-3 sed plerumque solitarii, 4-8 mm longi, ad basim c. 3-bracteolati.

Type: New South Wales: South Coast: Deua National Park, c. 13 km (direct) WSW of Moruya, 35°57'S, 149°54'E, *R. O. Makinson 1239 & G. Butler*, 23.xi.1992. (holotype MEL *717249* (Fig. 2); isotypes NE, NSW, CANB (CBG *9218263*), PERTH.

Shrub to 1.8 m high. *Branchlets* densely glandular-verrucose, glabrous. *Leaves* leathery, more or less concolorous, oblong-elliptic to obovate, 13–30 mm long, 5–10 mm wide, flat to somewhat concave above, glabrous; margins sometimes tinged maroon; apex rounded, truncate or sub-acute, apiculate. *Inflorescences* axillary, 1(–3)-flowered; peduncles very short to apparently absent, 0–2 mm long; pedicels slender, 4–8 mm long, c. 3 (sometimes caducous) bracteoles at base. Sepals very broad-ovate, c. 1 mm long; margins often ciliolate. *Petals* oblong-elliptic, c. 7 mm long, mostly white but outer surface often tinged with pink (especially in bud), not persisting in fruit, glabrous but minutely papillose within. *Staminal filaments* ciliate toward base, sparsely long-pilose in upper half (glabrous or only shortly pilose at Round Hill); anthers irregularly- to bi-glandular on abaxial surface, with a short, white apiculum. *Ovary* 0.75–1.0 mm long, glabrous; style 1.25–1.50 mm long at maturity. *Cocci* erect, prominently rostrate. *Seed* as in subsp. *myoporoides* (described and illustrated by Wilson 1970).

Distribution and Habitat

Occurs in south-east New South Wales in the Mt Donovan area of Deua National Park, at Round Hill south of Sassafras, Enchanted Hill north of Williamsdale, and in Little Forest north-west of Milton (Paul Wilson pers. comm., based on *J. Pickard* 2550 (NSW)). Notes accompanying herbarium specimens indicate that subsp. *brevipedunculata* grows near the summits of mountains in skeletal soil on rhyolite.

Notes

This subspecies differs from subsp. *myoporoides*, the only other subspecies found in south-east New South Wales, in having very short leaves and a peduncle not exceeding 2 mm long (and often so reduced that it is not readily visible). Some forms may bear a superficial resemblance to subsp. *epilosus*, but these are also distinguished by their short peduncles and the sparse, long-pilose hairs toward the apex of their stamen filaments. Collections from Enchanted Hill, Little Forest Trig (Paul Wilson pers comm.) and Round Hill differ slightly in leaf shape from the typical form. The Little Forest Trig specimen is sterile and the single flowering specimen from Round Hill (*E.F. Constable*, NSW 66252) has staminal filaments that are glabrous or only shortly hairy toward the apex.

Etymology

The epithet is Latin-derived (*brevi* = short, *pedunculatus* = pedunculate), and refers to the characteristically short peduncles found in the inflorescences of this subspecies.

Conservation Status

Populations of subsp. *brevipedunculata* are known from Deua National Park, Budawang Wilderness (Little Forest) and Morton National Park (Round Hill). The only collection from outside a reserve is that from Enchanted Hill. Notes on herbarium specimens suggest that this taxon can be locally common. It possibly occurs throughout more remote areas of Deua and nearby National Parks. A conservation code (Briggs and Leigh 1988) of 3RC is probably appropriate, but further surveys of the distribution and abundance of this subspecies would be worthwhile.

Selected Specimens Examined

New South Wales: Prominence, 1.9 km N from Coondella trig point, c. 16 km WSW from Moruya, *N. G. Walsh 1883*, 7.xii.1987 (MEL, CANB); Deua National Park, peak 3 km due W of Bundogeran Hill, *D. E. Albrecht 5314*, 1.i.1993 (MEL); Deua National Park, prominent rocky peak 2 km due N of Coondella trig, 21.x.1990, *D. E. Albrecht 4586* (MEL); Deua National Park, 1.8 km north-east of summit of Mt Donovan, *P. Beesley 401*, 28.iii.1985 (CANB); Round Hill, 3 miles S of Sassafras, *E. F. Constable*, 20.ix.1961 (NSW *66252*); Rocky Gully, northern slopes of Enchanted Hill, 13 km N of Williamsdale, *B. J. Lepschi 842*, 2.viii.1992 (MEL).

5. *Philotheca myoporoides* subsp. ***euroensis*** M. J. Bayly, subsp. nov.

Eriostemon myoporoides sensu J.H. Willis, *Handb. Pl. Victoria* 2: 332 (1973) *p. p.*, *non* DC. (1837).

Ramuli dense verrucosi. Folia late elliptica, 15–35 mm longa, 6–12 mm lata, conduplicata, falcata. Pedunculi conspicui, ad 7 mm longi. Pedicelli 1–4.

Type: Victoria: Garden Range, Euroa. *R. Thomas 108*, 20.v.1989. (holotype MEL *717487*) (Fig. 3).

Open *shrub* to 1 m high. *Branchlets* densely glandular-verrucose, green or sometimes tinged with maroon, glabrous. *Leaves* leathery, more or less concolorous, dotted with many small oil glands, broad elliptic, 15–35 mm long, 6–12 mm wide, strongly conduplicate, falcate, glabrous; midrib faintly to scarcely visible on lower surface; margins sometimes tinged maroon; apex obtuse, apiculate. *Inflorescences* axillary, 1–4 flowered; peduncles robust, angular, 0–7 mm long; pedicels, 3–6 mm long, with c. 3 or 4 ± caducous bracteoles at base. Sepals sub-orbicular to broad-ovate, c. 1 mm long, margins minutely ciliolate. *Petals* elliptic to slightly obovate, 5–7.5 mm long, white or tinged with pink, pink in bud, not persisting in fruit, glabrous but minutely papillose within. *Staminal filaments* ciliate for most of their length, sparsely pilose or glabrous toward the apex; anthers usually with two prominent glands on abaxial surface and a short white apiculum. *Ovary* c. 1.5–2 mm long, glabrous; style c. 1.5–2 mm long at maturity. *Cocci* prominently beaked.

Distribution and Habitat

Known only from an area near Euroa in Victoria, where it grows in shallow soil among granite boulders.

Notes

Subspecies *euroensis* most closely resembles forms of subsp. *myoporoides* from Victoria and southern New South Wales. Collections of subsp. *euroensis* have a uniform appearance, and are clearly distinguished from this latter taxon by their shorter (less than 35 mm long), broad-elliptic leaves, in which the midrib is faintly to scarcely visible on the abaxial surface, and which are strongly conduplicate and falcate when dry. Inflorescences of subspecies *euroensis* have 1–4 flowers, while those of subsp. *myoporoides* are (1–)3–9(–13)-flowered. The closest known populations of subsp. *myoporoides* are at Lake Mountain and near Toolangi to the south, and in the areas around Mt St Bernard, Mt Hotham, Mt Feathertop, Mt Cope and Falls Ck to the east.

Etymology

The epithet refers to the known distribution of this subspecies, near the town of Euroa.

Conservation Status

Subspecies *euroensis* is known only from four collections, and these were presumably taken within a few kilometres of each other (two certainly being from the same plant). A limited field search (two days) found only a single plant. More extensive study of this area (Ray Thomas pers. comm.) revealed a second plant nearby, but it appears this latter plant has since died. Further surveys in this and surrounding areas are required to determine the size and the distribution of populations. Given the relatively localised pockets of suitable habitat in this area, and the apparent rarity of this taxon, a conservation code (Briggs and Leigh 1988) of 2E is appropriate.

Specimens Examined

Victoria: Euroa area, *R. Thomas 20*, 6.xi.1988 (MEL); Mountain Hut Ck., Strathbogie (MEL *5219*); on and among granite rocks at Kelvin View, *J. H. Willis*, 12.vii.1951 (MEL).

6. *Philotheca myoporoides* subsp. ***obovatifolia*** M. J. Bayly, subsp. nov.

E. myoporoides subsp. *myoporoides p. p.* (Queensland populations) *sensu* Paul G. Wilson, *Nuytsia* 1: 40 (1970).

Ramuli verrucosi. Folia late obovata, 35–60 mm longa, 14–30 mm lata, plus minusve plana, apice obtusa vel leniter retusa, mucronata. Pedunculi conspicui, ad 10 mm longi. Pedicelli 1–5, ad basim c. 3 bracteolis caducis instructis.

Type: Queensland: Moreton District: Mt. Ernest 28°18'S, 152°42'E, *P. I. Forster 12364 & G. Leiper*, 10.xi.1992. (holotype BRI (AQ *5149469*); isotype MEL *719180* (Fig. 4)).

Woody *shrub* to c. 1 m high. *Branchlets* glandular-verrucose, green, glabrous. *Leaves* leathery, more or less concolorous but usually slightly paler on the lower surface, dotted with many small oil glands, broad-obovate, 35–60 mm long, 14–30 mm wide, more or less flat, glabrous; midrib prominent on lower surface, yellow; apex obtuse or sometimes very slightly retuse, shortly mucronate. *Inflorescences* axillary, 1–5-flowered; peduncles robust, angular, 1–10 mm long; pedicels 4–10 mm long, with 3 caducous bracteoles at base. Sepals broadly deltate to sub-orbicular, c. 1 mm long, margins sometimes ciliolate, not tinged with red. *Petals* oblong-elliptic, c. 8–9 mm long, white inside, tinged with pink outside, not persisting in fruit, papillose within. *Staminal filaments* ciliate for most of their length and with a few longer hairs toward the apex; anthers bi- or irregularly-glandular on abaxial surface, with a tapered, white apiculum. *Ovary* c. 1.0–1.5 mm long, glabrous. *Cocci* prominently beaked. *Seed* not seen.

Distribution and Habitat

This subspecies occurs in Queensland and is known only from three mountains (Mt Barney, Mt Lindesay and Mt Ernest) near the south-east border with New South Wales. Notes accompanying herbarium specimens indicate that this subspecies grows in heath or woodland (often dominated by *Leptospermum* spp.) on rhyolite.

Notes

Subspecies *obovatifolia* can be distinguished from subsp. *myoporoides* (in which it was included by Wilson (1970)) by its large, obovate leaves (Fig. 4), in which the midrib is strongly pronounced on the lower surface, and in which the apex is rounded and distinctly mucronate. Inflorescences of subsp. *obovatifolia* often have fewer flowers (1–5) than subsp. *myoporoides* [(1–)3–9(–13)]. Superficially (at least on herbarium sheets), subsp. *obovatifolia* most closely resembles specimens of the thick and coriaceous-leaved 'mountain form' of subsp. *myoporoides* (see notes under that taxon). There is a disjunction of several hundred kilometres between known occurrences of subsp. *obovatifolia* and the northernmost, linear-leaved (Fig. 1E) populations of subsp. *myoporoides* (north of Sydney), and an even greater disjunction between the former and populations of the 'mountain form' of subsp. *myoporoides*.

Etymology

The epithet is Latin-derived (*obovatus* = obovate, *folium* = leaf) and refers to the characteristic shape of the leaves in this subspecies.

Conservation Status

The known distribution of subsp. *obovatifolia* (on the three adjacent peaks of Mt Barney, Mt Lindesay and Mt Ernest) lies wholly within Mount Barney National Park. Notes accompanying herbarium specimens indicate that this subspecies can be locally common and, despite its limited distributional range, faces no identifiable threat. A conservation code (Briggs and Leigh 1988) of 2RCt is appropriate.

Selected Specimens Examined

Queensland: Mt. Barney, *S. L. Everist 1390*, 13.x.1935 (BRI); Mt. Lindesay, *N. Michael 2218*, 14.vii.1935 (BRI); Mt. Barney, *S. L. Everist 4137*, 25.ix.1949 (BRI); Mt. Barney, *W. McDonald*, 5.xii.1974 (BRI 491923); Mt. Barney, *C. Bell 538*, Jun. 1972 (BRI); Mt. Ernest, *P. I. Forster 12364*, 10.xi.1992 (BRI).

7. *Philotheca myoporoides* subsp. ***conduplicata*** (Paul G. Wilson) M. J. Bayly, comb. nov.

Eriostemon myoporoides subsp. *conduplicatus* Paul G. Wilson, *Nuytsia* 1: 41 (1970). Type: Howell, New South Wales, *J. H. Maiden and J. L. Boorman*, Aug. 1905. (holotype NSW *68742* (*fide* Wilson 1970))

This subspecies occurs in the border ranges of north-east New South Wales and in adjoining regions of south-east Queensland. It is an openly-branched shrub to c. 1.4 m high, often with leaves concentrated toward the apices of branches, and grows in the understorey of woodland and open forest on granite. It can be distinguished from subsp. *myoporoides* (to which it is most similar), by its comparatively smooth (rather than prominently glandular) branchlets, and by its leaves, which are strongly conduplicate and falcate (at least when dry, Fig. 1D). Subspecies *conduplicata* is broadly sympatric with, but clearly distinct from subsp. *epilosa* (see notes under that taxon). There are few recent collections of subsp. *conduplicata*, and limited field observations suggest that it is quite rare. The conservation status of this subspecies is worthy of further investigation, and tentative conservation code (Briggs and Leigh 1988) of 3RC is appropriate.

8. *Philotheca myoporoides* subsp. ***leichhardtii*** (Benth.) M. J. Bayly, comb. nov.

Eriostemon trachyphyllus var. *leichhardtii* Benth., *Fl. Austral.* 1: 333 (1863); *E. myoporoides* subsp. *leichhardtii* (Benth.) Paul G. Wilson, *Nuytsia* 1: 41 (1970). Type: Brroa [= Mt. Beerwah, Glasshouse Mountains, Queensland], *L. Leichhardt*. (holotype K (*fide* Wilson 1970); isotype MEL *4536*).

Eriostemon glasshousiensis Domin., *Bibl. Bot.* 89: 286 (1926). Type: Glasshouse Mountains (Slopes of Mt. Coonowrin), *C. T. White*, Sept. 1909. (isotype? BRI *04244* (*fide* Wilson 1970)).

[*E. scaber* auct. non Paxton: Benth., *Fl. Austral.* 1: 334 (1863) *p. p.* (Queensland specimen); Bailey, *Queensland Fl.* 1:91 (1899).]

[*E. myoporoides* var. *minor* auct. non Benth.: Benth., *Fl. Austral.* 1: 333 (1863) *p. p.*, Queensland specimen cited.]

Collections subsequent to the publication of Wilson's (1970) revision, show that this subspecies not only occurs in the Glasshouse Mountains but also further north, around Mt Cooroora [*P. I. Forster 16121*, BRI (AQ *634516*)], Cania Gorge (*M. Olsen 3538 and N. B. Byrnes*, BRI *222911*) and Kroombit Tops [*N. Gibson, TO11147*, BRI (AQ *547610*)]. Specimens from more northerly localities may have larger, oblong-elliptic (to slightly obovate) leaves, which can be somewhat glaucous. These specimens show variation in the number of flowers per inflorescence (some having one to several, rather than strictly solitary flowers), peduncle length (some either very shortly or non-pedunculate) and in the stamen filaments (some not being prominently long-pilose toward the apex).

As noted by Wilson (1970), material from the Glasshouse Mountains (Fig. 1C) can approach that of subsp. *queenslandica* (Fig. 1F). In this area the two taxa (which probably form a monophyletic group, Bayly and Ladiges unpublished) are broadly sympatric. From field observations in this region, subsp. *leichhardtii* is an erect, medium-sized shrub (to c. 1.5 m tall), restricted to rocky places on the mountains themselves, while subsp. *queenslandica* is a low subshrub (often c. 30–40, but up to c. 80 cm) occurring in sites of lower elevation in heath or wallum, or in the heathy understorey of open forests and woodlands. I have seen no specimens that could not be readily assigned to one taxon or the other.

9. *Philotheca myoporoides* subsp. ***queenslandica*** (C.T. White) M. J. Bayly, comb. nov.

Eriostemon queenslandicus C.T. White, *Proc. Roy. Soc. Queensland.* 53: 207 (1942); *E. myoporoides* subsp. *queenslandicus* (C.T. White) Paul G. Wilson, *Nuytsia* 1: 41 (1970). Type: Caloundra, Queensland, *S. L. Everist 454*, Aug. 1933. (holotype BRI *011386* (*fide* Wilson 1970)).

This subspecies is a distinctive, low-growing subshrub from coastal areas of south-east Queensland. It is most similar to subsp. *leichhardtii* (see notes under that subspecies).

Acknowledgments

Marco Duretto, Peter Neish, Anthony Vadala, Ian Thompson, Mandy Coulson, Nadia Marsh and Jim Kane all provided assistance with fieldwork. Paul Forster provided material of subsp. *leichhardtii* and subsp. *obovatifolia*. Don Foreman (as ABLO) arranged a photograph of the type of *E. affinis*. Neville Walsh assisted with the Latin diagnoses. Marco Duretto, Barbara Polly and Alison Kellow provided useful comments on the manuscript. I am grateful to Paul Wilson for allowing co-ordination of our publications, for useful comments on the manuscript and for freely providing his independent description and notes on subsp. *brevipedunculata*. I am also grateful to Pauline Ladiges for her ongoing supervision and for providing access to facilities of the School of Botany. The Queensland Department of Environment and Heritage, New South Wales National Parks and Wildlife Service and Victorian Department of Conservation and Natural Resources provided permission to collect material in parks and reserves under their control. The Directors and staff of BRI, NSW and AD provided necessary loan material, which was made available through facilities at MEL.

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Muelleria Vol. 11: 127–132 (1998)

Stenostegia congesta (Myrtaceae), a New Genus and Species from the Victoria River, Northern Territory, Australia.

A.R. Bean

Queensland Herbarium, Meiers Road, Indooroopilly, 4068, Queensland, Australia.

Abstract

Stenostegia congesta A.R.Bean, a new genus and species of the Myrtaceae subtribe Baeckeinae Benth. is described, illustrated, and compared to related taxa. A key to the genera of subtribe Baeckeinae is provided. The distribution, habitat and conservation status of the new species are discussed.

Introduction

Ferdinand Mueller was appointed botanist for the overland expedition led by A.C. Gregory in 1855–56, during which Mueller collected several thousand specimens, despite the difficult conditions (Cohn 1996). Many of the specimens he collected were of taxa new to science, and nearly all of these were subsequently described by Mueller in his Fragmenta Phytographiae Australiae and elsewhere.

Mueller collected a solitary specimen of a *Baeckea*-like plant, which he labelled "Camphoromyrtus umbellatus", from the Victoria River. He unselfishly sent this sole specimen to George Bentham at Kew, and it still resides in the Kew Herbarium today (Fig. 1).

The specimen is imperfect, bearing buds, but no flowers or fruits. Bentham (1867) included it in *Baeckea virgata* (J.R.Forst. & G.Forst.) Andr. (= *Babingtonia virgata* (J.R.Forst. & G.Forst.) F.Muell.), and it does bear a strong superficial resemblance to the form of that species from Victoria and southern New South Wales.

Several popular publications and treatments in floras of recent years list *Baeckea virgata* as occurring in the Northern Territory (e.g. Elliot & Jones 1982, Floyd 1989, Jeanes 1996). These records are all based on Mueller's solitary Victoria River collection in 1855–56.

Recent botanical exploration of the Gregory National Park, which includes a large section of the Victoria River gorge, have resulted in the collection of the first specimens of Mueller's *'Baeckea'* since late 1855 or early 1856. This taxon would fit into Bentham's broad concept of *Baeckea*, but taxonomic research into the group in recent years (Trudgen 1986, 1987; Bean 1995, 1997) has shown that *Baeckea* s. lat. is polyphyletic, and that recognition of several genera is warranted.

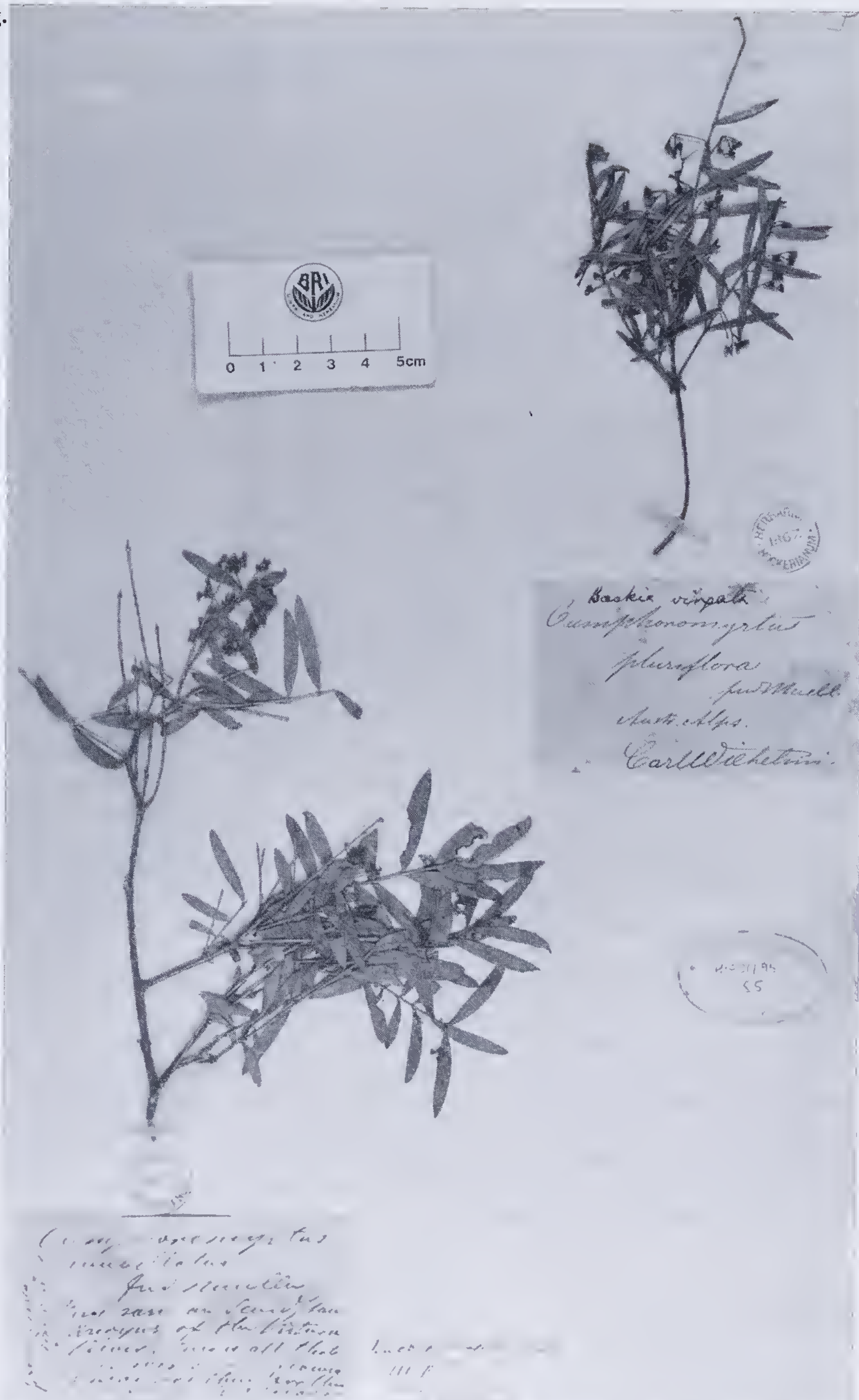
Studies of flowering and fruiting material recently procured has shown that the Victoria River taxon is not referable to either *Baeckea* L. or *Babingtonia* Lindl., and represents a new genus and species.

Taxonomy

Stenostegia A.R.Bean *gen. nov.*

Frutices glabri. Folia opposita, integra, punctata. Inflorescentiae solitariae, axillares, cymosae, pluriflorae. Hypanthium obconicum. Lobi calycis 5, compositi, obtusi. Petala 5, orbicularia. Stamina petalis breviora, omnia libera; anthera

Fig.



1. Mueller's collection of *Stenostegia congesta* (lower specimen only). The label reads "Camphoromyrtus umbellatus, Ferd. Mueller, Very rare on sandstone precipices of the Victoria River, this is all that ever was seen in flower, I was not there for this plant in right season. My only specimen."

versatilia, rimis longisparallelis aperientia. Stylus simplex, teres; stigma capitatum. Ovarium 3-loculare. Ovula 8–12 in quoquo loculo, in seriebus duabus obliquis secus placentam disposita. Fructus capsulares, hemisphaerici, valvis inclusis. Semina semidiscoidea, lateribus planis et dorsis rotundatis.

Typus: Stenostegia congesta A.R.Bean

Glabrous *shrubs*. *Leaves* opposite, entire, glandular-dotted. Inflorescences solitary, axillary, cymose, many-flowered. *Hypanthium* obconical. Calyx lobes 5, compound, obtuse. Petals 5, orbicular. Stamens shorter than the petals, all free; anthers versatile, opening by long parallel slits. Style simple, terete; stigma capitate. Ovary 3-locular. Ovules 8–12 per loculus, arranged in two oblique rows along placenta. Fruits capsular, hemispherical, valves enclosed. Seeds discoid, with flat sides and rounded backs.

A monotypic genus endemic to Australia

Etymology

The name *Stenostegia* is derived from the Greek *stenos* meaning narrow, and *stege* meaning shelter. This is in reference to the habitat of the genus on sheltered sites only a few metres wide.

Notes

A key to the genera of Subtribe Baeckeinae (excluding Western Australia) is presented below. Species belonging to these genera, with the exception of *Astartea* spp., have traditionally been included in *Baeckea* L.

Stenostegia is only distantly related to *Triplarina* Raf., *Euryomyrtus* Schauer and *Ochrosperma* Trudgen, all of which differ fundamentally by their reniform, papillose, turgid seeds. *Stenostegia* is closely related to *Babingtonia* Lindl., differing however by the versatile anthers dehiscing by long parallel slits, whereas all *Babingtonia* spp. have anthers adnate to the filaments, and opening by pores or short oblique slits. The multiple cymes of the inflorescence in *Stenostegia* are not found in *Babingtonia* (inflorescences solitary or in a simple dichasial cyme of up to 7 flowers). In *Stenostegia*, the ovules are arranged obliquely along the placenta, whereas in *Babingtonia* the ovules are either radially arranged or in parallel rows on the placenta. Furthermore, the tightly-grouped, strictly antesepalous stamens found in *Stenostegia* are not a feature of any *Babingtonia* spp., with the exception of *B. taxifolia* (Merr.) A.R.Bean.

Stenostegia differs from *Baeckea* by the compound inflorescences (strictly solitary in *Baeckea*); well developed peduncles (peduncles absent or rudimentary in *Baeckea*); compound calyx-lobes (illustrated in Bean 1997: 631) which in *Baeckea* are known only from *B. brevifolia* (Rudge) DC.; the ovules arranged obliquely along the placenta (parallel rows in *Baeckea*); and the 3-locular ovary ((1–) 2-locular for *Baeckea*, except for some specimens of *B. frutescens* L.).

Stenostegia differs from *Astartea* DC. by the compound inflorescences (strictly solitary in *Astartea*); compound calyx-lobes (simple in *Astartea*) and filaments all free (fused into groups in *Astartea*).

The stipules found in *Stenostegia* are not found in *Babingtonia, Astartea* or *Baeckea*. The raised longitudinal veins in the leaves of *Stenostegia* are unique in the subtribe Baeckeinae.

Key to the genera comprising subtribe Baeckeinae in Australia (excluding Western Australia), New Caledonia and Malesia.

1. Ovules and seeds reniform, not angular, ovary 3-locular..2
1. Ovules and seeds discoid, angular, ovary 2- or 3-locular......................................4

2. Some stamens opposite centre of petals .... **Euryomyrtus**
2. No stamens opposite centre of petals 3
3. Ovules 2 per loculus, stamens 5–8 .... **Ochrosperma**
3. Ovules 8–13 per loculus, stamens 14–18 .... **Triplarina**
4. Stamens fused into 5 antesepalous bundles .... **Astartea**
4. Stamens completely free 5
5. Anthers adnate, dehiscing by pores or short divergent slits .... **Babingtonia**
5. Anthers versatile, dehiscing by long parallel slits 6
6. Inflorescences 1-flowered, peduncles < 0.5 mm long or absent, calyx lobes simple, ovary 2- or rarely 3-locular .... **Baeckea**
6. Inflorescences 3–35-flowered, peduncles 3–9 mm long, calyx lobes compound, ovary 3-locular .... **Stenostegia**

Stenostegia congesta A.R.Bean *sp. nov.*

Frutex cortice badio fibroso. Folia lanceolata ad ellipticam, 17–35 mm longa, venis 3–5 longitudinalibus. Inflorescentia 3–35-flora. Hypanthium laeve, obconicum. Stamina 11–15, filamentis teretibus.

Typus: Northern Territory. VICTORIA RIVER DISTRICT: Gregory National Park, c. 4.5 km SW of Victoria River Roadhouse, 15°38' 59"S, 131°05' 49"E, *I. Cowie 7320 & C. Mangion*, 17.ix.1996, (holotype BRI [2 sheets + spirit], isotypes AD, CANB, DNA, K, L, MEL, MO, NE, NSW, NT, NY, PERTH, QRS, US, distribuendi).

Shrub to 4 m high, branchlets pendulous. Bark red-brown, persistent, fibrous, furrowed. Stem flanges pale brown, flat, not winged, not warty, margins entire. *Leaves* lanceolate to elliptical, 17–35 mm long, 3.5–5.5 mm wide, straight, flat, not keeled, slightly discolorous, apex acute, oil glands prominent on lower surface, c. 0.5 mm apart; 3 or 5 longitudinal veins readily visible on abaxial surface, invisible on adaxial surface; petioles c. 1.0 mm long; stipules present, linear, c. 0.5 mm long, caducous. *Inflorescence* axillary, solitary, dichasially cymose, 3–35 flowered; peduncles 3–9 mm long; bracts and bracteoles numerous, persistent, elliptical to lanceolate, up to 2.2 mm long, acute or obtuse; stipes 3–6 mm long. Hypanthium obconical, 1.8–2.2 mm long, fused to the ovary for half to two-thirds of its length, smooth, glandular, unribbed or with 5 faint ribs extending longitudinally from calyx lobes, floral disc concave; calyx lobes compound; inner lobe obtuse, c. 0.5 × 1.0 mm, thin, margins entire or fimbriate; outer lobe c. 0.3 mm long, thick, erect, obtuse, not exceeding inner lobe. Corolla up to 5 mm across; petals orbicular, 1.3–1.8 × 1.4–2.0 mm, white, oil glands present, margins entire. Stamens 11–15, in groups of 2–3 (rarely 4) opposite the calyx lobes, each about the same length; filaments terete, c. 0.9 mm long, not geniculate, connective-gland brown, less than half anther length; anthers versatile, dehiscing by parallel slits, anther cells free. Style terete, up to 1.5 mm long after anthesis, set into a pit; stigma broadly capitate. Ovary 3-locular, ovules 8–12 per loculus, arranged in two oblique rows along placenta. Fruit hemispherical, 2.0–2.3 × 2.5–3.5 mm, valves broadly deltate, rather woody, enclosed. Seeds discoid, c. 0.6 mm long, brown, with flat to convex sides and rounded backs, surface minutely reticulate. (Fig. 2)

Distribution

Stenostegia congesta is restricted to a short section of the Victoria River, and adjacent tributaries, in north-western Northern Territory.

Ecology

It grows at the bases of ephemeral waterfalls, or on ledges of small sandstone cliffs, in areas which receive perennial seepage. Some associated species are *Melaleuca* sp.

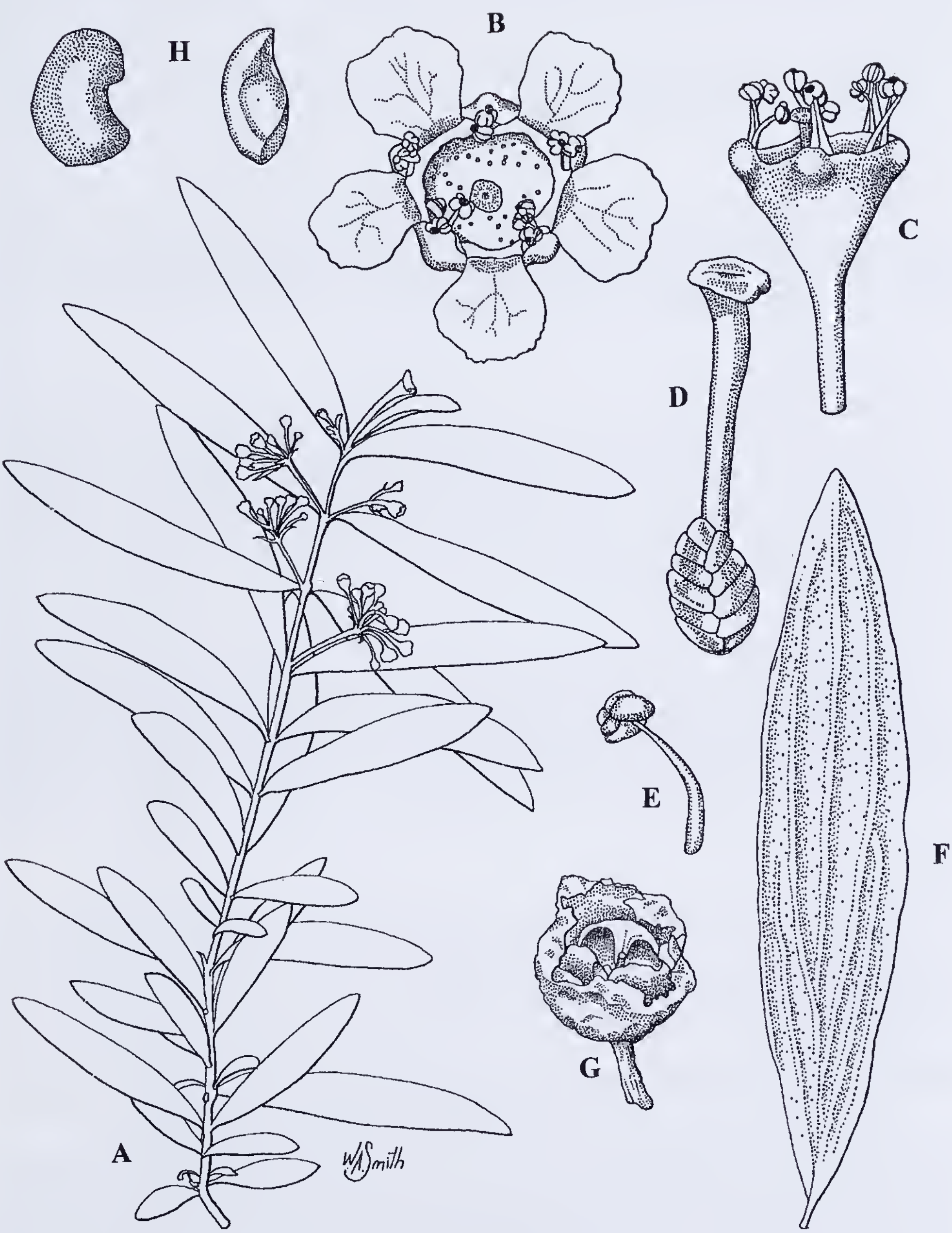


Fig. 2. *Stenostegia congesta*. **A**. flowering branchlet x 1.5. **B**. flower from above x 10. **C**. lateral view of flower, petals removed x 10. **D**. style and ovule arrangement x 20. **E**. anther and filament x 20. **F**. leaf, abaxial surface x 4. **G**. fruit x 10. H. seed, two views x 40. **A**,**F**,**G**,**H** *Cowie 7320 & Mangion* (holotype); **B**,**C**,**D**,**E** *Cowie 7324 & Mangion*.

nov. (see Craven, this volume), *Dicranopteris linearis* (Burm.f.) Underw., *Eucalyptus aspera* F.Muell. and *E. brachyandra* F.Muell. Flowers are recorded in September.

Etymology

The specific epithet *congesta* means congested, in reference to the tightly clustered flowers of the inflorescence.

Conservation Status

The risk category for *Stenostegia congesta* according to the criteria of Chalson and Keith (1995) is 'priority for investigation' (criterion a). The species is known from only a few small populations, but the area is poorly explored, and the probability of locating more populations is high.

Specimens Examined

Northern Territory: 8 km SSW of Victoria River bridge, *D.E. Albrecht 7425 & P. Latz*, 17.iv.1996 (BRI, DNA, MEL); Gregory N.P., c. 7.3 km SSW of Victoria River Roadhouse, *I. Cowie 7324 & C. Mangion*, 17.ix.1996 (BRI, CANB, DNA, HO, MEL, NSW, PERTH); Gregory N.P., c. 6 km SW of Victoria River Roadhouse, *I. Cowie 7326 & C. Mangion*, 17.ix.1996 (BRI, CANB, DNA, MEL); sandstone precipices of the Victoria River, *F. Mueller* s.n., in 1855-56 (K).

Acknowledgements

I thank Clyde Dunlop for initiating ground searches for the species, Ian Cowie for his excellent collections, Peter Bostock for the Latin diagnoses, the Director of K for the loan of Mueller's specimen, Paul Robins for photographing that specimen, and Will Smith (BRI) for the illustrations.

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A New, Rare Victorian Subspecies of *Eucalyptus leucoxylon* F. Muell.

K. Rule

Dept. Botany, La Trobe University, Bundoora, VIC.

Abstract

Eucalyptus leucoxylon subsp. *bellarinensis*, a rare, pruinose and relatively large-fruited form of Yellow Gum occurring in coastal Central Victoria, is described and comments regarding its infraspecific affinities, distributions and conservation status are given.

Introduction

The variable nature of *Eucalyptus leucoxylon* F. Muell. is unequalled within the genus. Its complexity is a result of its extensive distribution, which extends from the Flinders Ranges to North-eastern Victoria, and the numerous habitats it occupies. Boland (1979) provided formal descriptions of four morphological and geographical forms: subsp. *leucoxylon* Boland, subsp. *megalocarpa* Boland, subsp. *pruinosa* Boland and subsp. *petiolaris* Boland. Two additional taxa were described by Rule (1991): subsp. *stephaniae* Rule and subsp. *connata* Rule. In 1992 subsp. *petiolaris* was elevated in rank to *E. petiolaris* (Boland) Rule.

Further study, however, has demonstrated that an additional morphological and geographical form of *E. leucoxylon* is sufficiently distinctive in its combination of features to warrant subspecific recognition. It occurs on the Bellarine Peninsula near Geelong in coastal Central Victoria and grows as a depauperate, often mallee-like tree with features including waxy, frequently connate juvenile leaves and relatively large fruits borne on markedly long pedicels.

Eucalyptus leucoxylon F Muell subsp. ***bellarinensis*** K Rule subsp. nov.

Eucalyptus leucoxyloni F. Muell. subsp. *connatae* K. Rule et subsp. *pruinosae* Boland affinis sed ambabo fructibus majoribus et pedicellis longioribus differt; necnon a subsp. *connata* foliis juvenilibus pruinosis, et a subsp. *pruinosa* foliis juvenilibus connatis constanter differt.

Type: Grounds of Anglican Church, Ocean Grove, *K. Rule 9688*, 4 viii 1996 (holotype MEL *2042455;* isotypes AD, NSW, CANB)

Small, umbrageous, multi-trunked *trees* to 12 m high. Bark on upper trunk and branches smooth, mottled, white with grey; bark on base and lower trunk light brown or grey-brown, fibrous, persistent as slabs and chunks, box-like in appearance. Juvenile leaves opposite and sessile for more than 25 pairs, connate for numerous pairs, cordate or broadly ovate, blue-grey, discolorous, waxy, to 9 cm long and 8 cm wide. Lightly waxy pre-adult leaves occasionally present in the canopy. Adult leaves petiolate, the petiole 1–1.5 cm long, the blade lanceolate or broadly lanceolate, 10–16 cm long, 1.5–3 cm wide, blue-green, sub-lustrous, acuminate. Inflorescences axillary, simple, 3-flowered; peduncles slender, to 2 cm long. Floral buds on pedicels 2–3 cm long, the floral bud proper globular, excluding the beak 5–7 mm long, 5–7 mm wide, unscarred, the sepaline operculum intact,

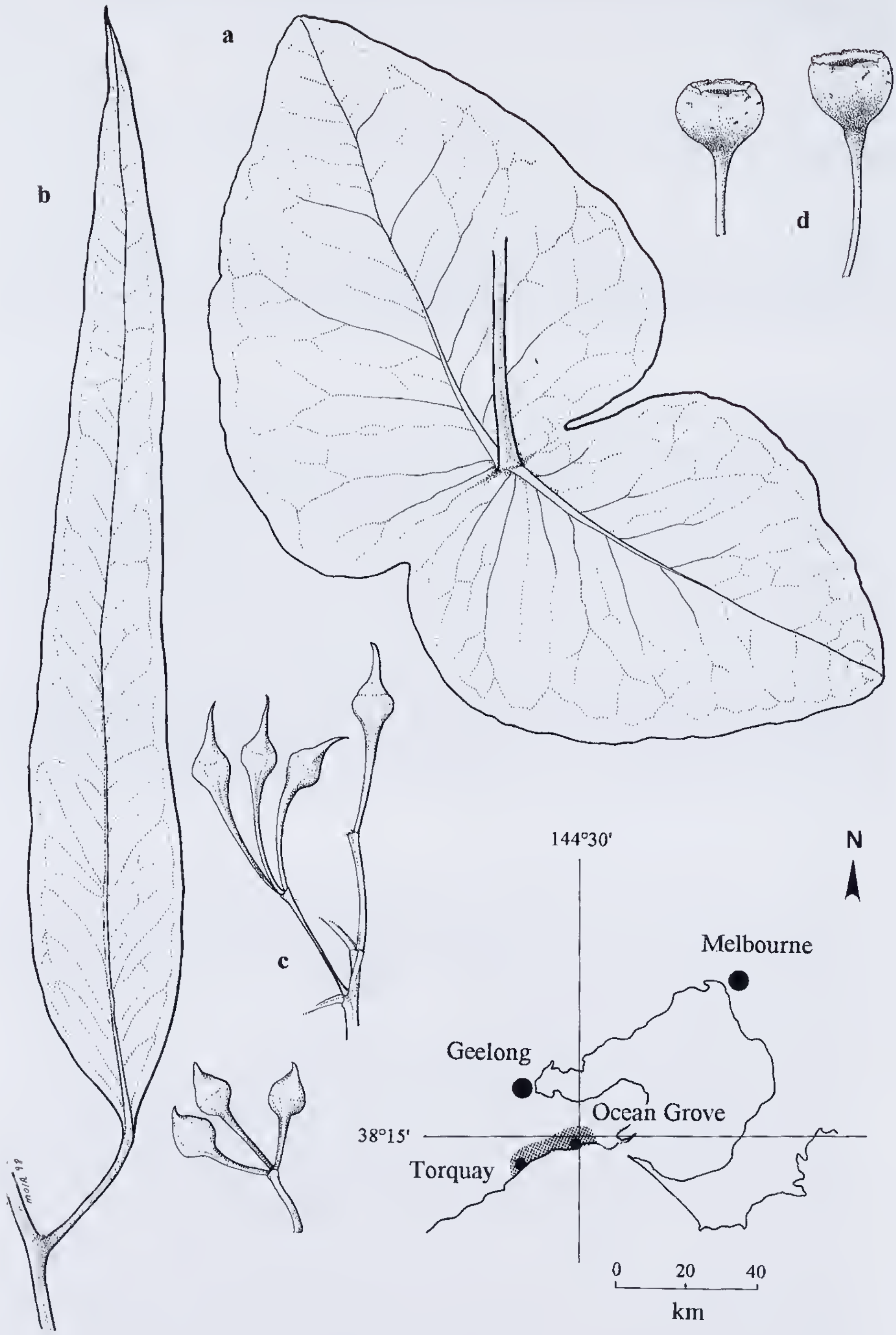

Fig. 1. ad *Eucalyptus leucoxylon* subsp. *bellarinensis* (*Rule 9688*): **a** juvenile leaf x1; **b** adult leaf x1; **c** buds x1; **d** fruit x1; distribution of *Eucalyptus leucoxylon* subsp. *bellarinensis*.

often with a conspicuous beak to 9 mm long, sometimes lightly waxy; outer whorls of stamens as staminodes; filaments white; staminophore often persisting with fruit. Fruits hemispherical, 8–10 mm long, 9–13(–14) mm wide; discs descending; valves enclosed; pedicels 15–27 mm long, occasionally swollen immediately below the hypanthium; locules 5–7. (Fig 1)

Phenology

Flowers: April and May.

Additional specimens examined:

Victoria: Sunset Strip adjacent to Bell Bvd., Jan Juc, *P. Carolan*, 14 v 1986 (MEL *684518*); North-east of Ocean Grove on Wallington Road, 300 m north of Rhinds Road, *K. Rule 9745 and M. Trengove*, 14 III 1997 (MEL); Kingston Park, Ocean Grove, *K. Rule 9746 and M. Trengove*, 14 III 1997 (MEL); Adjacent to the entrance to the Ocean Grove Nature Reserve, *K. Rule 9747 and M. Trengove*, 14 III 1997 (MEL); Deep Creek Reserve, Torquay, *K. Rule 9748 and M. Trengove*, 14 III 1997 (MEL); Spring Creek Reserve, Torquay, *K. Rule 9749 and M. Trengove*, 14 III 1997 (MEL); 300 m north of the Great. Ocean Road, Jan Juc, *K. Rule 9750 and M. Trengove*, 14 III 1997 (MEL).

Distribution and habitat

Populations of the new subspecies are known only from the Bellarine Peninsula, occurring on coastal sites close to the Southern Ocean in the vicinity of Ocean Grove and Torquay, with a small remnant population at the western end of the nearby Lake Connewarre. All sites are often blasted by cool, salt-laden winds. Its preferred soils are heavy clays which are water-logged in winter. (Fig. 1)

Scattered remnants on the western side of Jan Juc, previously included with subsp. *connata*, which have waxy juvenile leaves and fruit sizes and pedicel lengths within the range of subsp. *bellarinensis*, are now considered a part of the new subspecies.

Etymology

The subspecific name is in reference to the location of the new subspecies on the Bellarine Peninsula near Geelong in coastal Central Victoria.

Conservation status

The new subspecies now exists on outskirts of the developing townships of Ocean Grove and Torquay. Clearing for housing blocks and farms have left only remnants on farms, at roadsides and in a few small nature reserves. There is an urgent need for conservation strategies to preserve the remaining unprotected populations. In accordance with Briggs & Leigh (1989), a status of 2V is recommended.

Associated species

Eucalyptus viminalis Labill. has been observed in association with the new subspecies and *E. ovata* Labill.often occurs in the vicinity. *Eucalyptus camaldulensis* Dehnh. occurs adjacent to the Lake Connewarre population.

Discussion

Eucalyptus leucoxylon subsp. *bellarinensis* is distinctive in its combination of features which include a coastal habitat, a stocking of box-like bark, waxy connate juvenile leaves, globular buds with often prominently beaked opercula and relatively large, hemispherical fruits borne on markedly long pedicels. It is similar to subsp.

connata in having globular buds, hemispherical fruits (distinctly wider than long) and frequently connate juvenile leaves, but differs from that subspecies which has a less exposed subcoastal habitat, is smooth-barked, has a shorter-beaked operculum and generally smaller fruits borne on shorter pedicels (in subsp. connata fruits 6–9 mm long, 8–11 mm wide and pedicels 8–12 mm long).

The waxy features of subsp. *bellarinensis* also suggest a close relationship to typical subsp. *pruinosa*, but it differs from that subspecies which is smooth-barked, has generally smaller adult leaves (in subsp. *pruinosa* adult leaves to 15 cm long, 2 cm wide), smaller buds without a prominent beak (the beak, if present, up to 2 mm long), smaller fruits borne on shorter pedicels (in subsp. *pruinosa* fruits 5–7 mm long, 6–9 mm wide and pedicels 4–8 mm long). Furthermore, individuals of typical subsp. *pruinosa* exhibit a low frequency of connate pairs of juvenile leaves. In fact, Mr. C. D. Boomsma of Adelaide (pers. comm.) has noted that connation is rarely observed in the population from which the type of subsp. *pruinosa* was supposed to have been collected (near Bethany in the Barossa Valley of South Australia). Unlike the typical populations of subsp. pru*i*nosa, in Central Victorian populations individuals exhibit a high frequency of connate pairs of juvenile leaves.

The new subspecies may be distinguished from the other subspecies of *Eucalyptus leucoxylon* by the following key:

1. Wax present on juvenile leaves and/or branchlets, buds and fruits.
2. Pedicels 15–27 mm long (1.25–2.3 times longer than fruits)...subsp. *bellarinensis*
2. Pedicels 3–8 mm long (equal to or shorter than fruit length)........subsp. *pruinosa*
1. Wax absent from all structures
3. Juvenile leaves frequently connate.. subsp. *connata*
3. Juvenile leaves never connate
4. Pedicels 3–7 mm long (shorter than fruits); dried pellicle present over the orifice of the fruit...subsp. *stephaniae*
4. Pedicels 8–30 mm long (equal to or longer than fruits); pellicle absent
5. Fruits 12–16 mm long, 10–15 mm wide; adult leaves wider than 2.5 cm...subsp. *megalocarpa*
5. Fruits 9-13 mm long, 7–10 mm wide; adult leaves less than 2.5 cm wide...subsp. *leucoxylon*

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